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GROUND WATER CONTAMINATION AND PROTECTION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TOXIC SUBSTANCES AND
ENVIRONMENTAL OVERSIGHT

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

NINETY-NINTH CONGRESS

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GROUND WATER CONTAMINATION AND PROTECTION

THURSDAY, OCTOBER 24, 1985

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON TOXIC SUBSTANCES AND
ENVIRONMENTAL OVERSIGHT,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:07 a.m., in room SD-406, Dirksen Senate Office Building, Hon. David F. Durenberger (chairman of the subcommittee) presiding.

Present: Senators Durenberger, Baucus, and Burdick.

OPENING STATEMENT OF HON. DAVE DURENBERGER, U.S. SENATOR FROM THE STATE OF MINNESOTA

Senator DURENBERGER. This is the fourth in a series of hearings being held by this subcommittee to examine the question of ground water contamination and ground water protection.

Today it will be our pleasure to hear from a group of witnesses representing American commerce and industry. As most of you know, these are oversight hearings. There is no legislation pending before the subcommittee at this time, but there is some good news on that score.

If our procedures were reversed and our witnesses could ask the Senators the questions, I am sure that the first thing that many of you would want to know is what progress we have made on the drinking water conference.

I am pleased to tell you that the Senate conferees met in caucus yesterday and the prospects for an early conclusion of the drinking water conference are good.

Several weeks ago, I proposed in a speech to the National Water Alliance that the Senate conferees make an offer to the House on ground water that would basically provide congressional authorization for the program that the President has already created. We have drafted language which would accomplish just that, and it has been reviewed and studied by the Senate conferees. I am now authorized by my colleagues to make a formal proposal to the House along those lines. I think that once we get that item on the table, things will move along quite well on the other issues that remain unresolved.

So that is the good news. I have had an opportunity to review the testimony prepared by almost all of the witnesses for this hearing, and I find that there is a great deal of agreement among the seven individuals who will appear before us today. They want ground water programs run by the States, not by the Federal Government. They want States to use classification schemes that provide differential levels of protection depending on the use or potential use of the ground water resource. They want the Federal Government to provide financial and technical assistance to the States. And they want the Federal Government to defer to the traditional land use and water allocation authorities that have always rested with States and local governments.

I shall do my best to keep the hearing interesting by challenging those unanimous conclusions in the round of questions that will follow the testimony.

With that, I suggest that we get underway. Our first witness, Mr. William Thomas, is an attorney with the American Bar Foundation. For the last 6 months, Mr. Thomas has also been serving as the coordinator of the ground water task force of the National Water Alliance.

As the cochair of that organization, I have watched the work of the task force closely, and I am quite pleased that they can deliver that work to the subcommittee here this morning.

Mr. Thomas will be introduced by Jim Magner, who is the executive director of the alliance.

Jim, please proceed.

STATEMENT OF WILLIAM A. THOMAS, COORDINATOR, GROUNDWATER TASK FORCE, THE NATIONAL WATER ALLIANCE, ACCOMPANIED BY JAMES J. MAGNER, EXECUTIVE DIRECTOR, NATIONAL WATER ALLIANCE

Mr. MAGNER. Thank you, Mr. Chairman. On behalf of the board of directors, and all of the members of the National Water Alliance, I would like to thank you for the opportunity to testify on the subject of ground water protection.

We would like to compliment you on your leadership in conducting this series of ground water hearings, and we compliment you on your leadership in conducting this series of ground water hearings, and we compliment your staff on their thorough efforts to include as many interested parties as possible and to cover the whole range of related issues.

As you stated, I am accompanied this morning by Mr. William A. Thomas, who is the coordinator of the National Water Alliance ground water task force. Mr. Thomas is with the American Bar Foundation.

Also, as you suggested, we would like to submit our full statement for the record, summarize some of the major points, and answer any questions that the committee may have.

Senator DURENBERGER. Let me say, the written statements of all of the witnesses this morning will be made part of the record.

Mr. MAGNER. The National Water Alliance consists of task forces on various topics of specific interest to the members. The ground water task force is one of four currently organized groups established by the board. The group has been meeting since January and is developing a general ground water policy statement, a consensus statement, and some specific policy recommendations which are consistent with that statement. These recommendations were the central subject of the alliance's recent conference, Water Policy: 1985, held here in Washington.

Today's testimony is a summary of the conference conclusions and the consensus statement which has evolved up to this point.

Mr. Thomas, the coordinator of the task force, will summarize the major points, which are certainly not the only issues that the task force has considered.

Mr. THOMAS. Mr. Chairman, as Mr. Magner indicated, these are just several summary points from a consensus statement, and I will touch on those that deal mostly with congressional policy and congressional action.

We do find that a need exists for a clear and coherent national ground water policy. A number of Federal statutes and regulations relate in some way to ground water management, but we have no coordinated policy. This lack leads to fragmented implementation of ground water programs, which in turn reduces public confidence that ground water is being appropriately managed.

A similar situation also is found in many of our States.

We have an opportunity now in many instances to act prospectively, rather than to react to past abuses, in ensuring a adequate ground water supply for this and future generations.

Ground water policy should not be based upon either of two presumably false assumptions. First, that the Nation must inevitably exhaust its ground water resources; or, second, that future generations can be assured now of sufficient quantities of ground water of suitable quality and quantity to satisfy their increased needs.

Many incentives and innovative management plans have yet to be explored.

Integration of relationships should be the dominant theme throughout any national ground water policy, the correlation between ground water quality and quantity, the interdependence of surface water and ground water, the relationship of water availability and water cost, the coordination of intergovernmental and of public and private activities, and the balance between present and future generations.

Now a few specifics.

Continued availability of usable water supplies is the dominant theme in any workable ground water policy. This requires attention to both quantity and quality. We have not always done that in the past, Mr. Chairman. Any discussion of ground water supply has little meaning without concurrent consideration of both quantity and quality.

The primary consideration of all levels of government, Federal, State, and local, must be the protection of aquifers from contamination and excess depletion. The cost of reducing ground water contamination far exceeds that of dealing with comparable surface water contamination, and the time required, contrary to what we sometimes see in the press, might have to be measured in terms of human generations, rather than in congressional terms.

Historical, legal, and political approaches toward allocation of ground water among potential users tend to treat ground water independently from surface water. This disregard for hydrological reality resulted largely from narrowly focused judicial decisions issued as they must be on a case by case basis.

We, as a nation, no longer can afford to ignore the long-term hydrological consequences of the way we manage our aquifers. Some States, indeed, have demonstrated leadership, but a concerted effort toward conjunctive management of ground water and surface water is long overdue nationwide, but it must be coordinated with State and local governments.

This raises the all important question of intergovernmental relations that you, Mr. Chairman, mentioned in your opening remarks.

State and local governments, we think, will retain primacy in managing ground water because of both historical precedent and hydrological conditions that vary so widely across our Nation. Those State and local governments should coordinate, where appropriate, urban and agricultural developments, and other land uses that affect ground water quantity and quality.

Local governments, for example, should be encouraged by the Federal and State Governments to develop 5- and 10-year water budgets that incorporate the best estimates of future supplies and demands. Doing so would have alleviated many of the problems in the Midwest drought this summer, for example.

Interstate compacts can be devised to allocate water from water courses across State borders. These compacts would implicitly require coordination of ground water with surface water, which they now do not. It would be far preferable to allocations made by Congress or by the U.S. Supreme Court.

Some interstate aquifers that are not directly related to interstate surface waters might also be managed through interstate compacts. But in any instance, any Federal role in implementing those compacts should be clearly stated, and that presently is not the case.

Statutes mandate Federal involvement in establishing public health and drinking water standards, and restoring hazardous waste sites, and in protecting aquifers that may be the sole source of drinking water for a given human population. The Federal Government, thus, has an obvious role in the design and the management of interstate projects that concern ground water, and this role could increase if water becomes more and more a commodity in interstate commerce.

However, many important questions of Federal jurisdiction remain unanswered with regard to ground waters, which is not necessarily the case with surface waters.

A review and possible consolidation of Federal statutes that affect the quantity and quality of ground water may be required.

The Federal Government has the responsibility to facilitate the resolution of Indian claims to water and to oversee the reserved rights to ground water for use on its land and on lands held in trust. Settlements through negotiation by all parties with direct interests are preferable to legislated or litigated settlements. A related issue is water management on Federal lands that are hydrologically linked to private and other public lands.

Sound ground water management at all levels of government, and safe and efficient action by the private sector, requires complete and accurate information. Current public and private research and demonstration programs should be strengthened, and new ones should be undertaken as needed, including methods for decontaminating polluted ground waters and projects for demonstrating the beneficial effects of water recharge and other conservation and reclamation activities.

We must remember that supply and demand can be balanced by decreasing demand as well as by increasing supply, which historically has been our answer to imbalances between the two. Strict nondegradation of our water supplies is not feasible if they are to be used at all, but strict adherence to a policy of limiting degradation is not only feasible, but also necessary. Ground water becomes contaminated largely from nonpoint sources of pollution, rather than from the more easily controlled point sources. Many proposed management plans to reduce the degree of contamination have yet to be explored, including promising ones that combine the interests and abilities of private and public sectors.

Public education projects at all levels of government and by many private organizations promote protection of our ground water resources. These public and private efforts should continue and should include greater effort to educate water users about the true cost of establishing and maintaining water supply systems. This would help reduce the illusion that water is a cheap resource that can be used without concern for continued availability in large quantities of satisfactory quality.

The Federal Government should continue its role as the central depository for technical and scientific information to support the development of ground water programs. Public health aspects of water supplies must be included in any comprehensive information base, but other aspects of water use, such as maintenance of various ecosystem values, cannot be overlooked.

The task force finds a clear need for a national ground water policy. This policy should further a Federal-State partnership that encourages active participation by the private sector. Regardless of who might initiate or adopt a ground water policy, it probably will be implemented at the State and local level with respect to individual aquifers.

Any ground water policy should as a general rule be based upon the long-term effects of using our ground water resources, using ground water supplies, rather than upon the short-term economic incentives that might encourage excessive ground water withdrawals. Use and protection of ground water are not inconsistent. Contamination of ground water will create costs that must be borne by future generations, and many of these costs are largely unnecessary in light of available ground water management practices.

In summary, Mr. Chairman, the need for a Federal ground water policy is clear. It should further a Federal/State partnership that encourages active participation by the private sector. Regardless of who initiates or who adopts the ground water policy, it probably will be implemented at the State or local level with respect to individual aquifers. Fruitful discussions of timetables for this implementation or development of management plans must await appearance of specific policy objectives.

Contamination and depletion of ground water resources will create costs that must be borne by future generations. We have an obligation as a nation, both to present and future generations, to ameliorate those costs and to act prudently on their behalf.

Thank you very much for the time you have given us today.

Senator DURENBERGER. Tom, thank you very much.

Our second witness is Mr. Roger Strelow, who is the vice president for corporate environmental programs at General Electric, appearing before us in his capacity as the chair of the ground water project of the National Environmental Development Association, which recently completed a ground water policy statement.

I recently had the opportunity to visit with John Quarles about the content of the proposal. John serves as the vice chair. I am certainly looking forward to a chance to hear the whole package.

Roger, we are ready.

STATEMENT OF ROGER STRELOW, VICE PRESIDENT, CORPORATE ENVIRONMENTAL PROGRAMS, GENERAL ELECTRIC; CHAIRMAN, GROUND WATER PROJECT, THE NATIONAL ENVIRONMENTAL DEVELOPMENT ASSOCIATION

Mr. STRELOW. Thank you, Mr. Chairman.

As you know, NEDA is a broad-based coalition of diverse industries, agriculture, and labor. We appreciate this opportunity to share our views, and we appreciate your leadership in bringing this issue to public attention as it deserves.

The policy paper which you referred to, which we just recently issued, is being submitted as part of the record, as well as a written statement. I would just like to highlight a few points, and since you very well summarized many of the key elements of our views, I will try to emphasize some of the reasons for those views, rather than simply stating them.

First of all, ground water is a very important resource for all of us. I think that this is becoming increasingly clear. Although contamination of ground water presently appears to be limited, it is a serious problem. Cleanup is needed in a number of locations. Moreover, experience has shown industry and others that we should prevent today what we will otherwise have to clean up tomorrow. So we are certainly in favor of a preventive approach.

A lot is already being done to maintain and restore ground water quality by both States and the Federal Government, but we certainly agree that more effective programs are needed. RCRA, Superfund, the Safe Drinking Water Act, which you referred to, and other State and Federal laws provide a solid foundation to begin to deal with many of the ground water quality issues.

In our view, we should build on top of this solid foundation a new type of State and Federal partnership in which States, supported actively by the Federal Government, make ground water protection a national priority.

What is needed, then? In our view perhaps three key things: One, certainly a much better inventory of the ground water resources, the contaminants that are found in them, and the sources of those contaminants. This is a very spotty thing at the moment, and you can't really deal effectively with any issue such as this until the resource and the contaminants have been better defined. We simply have to improve our knowledge fast.

Second, classification of aquifers based on their current and future uses, so that intelligent priorities for action can be set.

Third, adequate controls on those sources causing or threatening to cause contamination in particular situations. Several Federal laws that I have mentioned, for example, are already dealing quite extensively with industrial wastes where they may be having an effect on ground water. But, as you know, there is a wide variety of sources, from septic tanks to the salt used for road deicing in the Northeast, agricultural practices, et cetera, which need to be covered where appropriate, as well as industrial activities. Of course, this will vary a good deal from one location to another.

If these actions are needed, who should do it and why?

First of all, in addition to its RCRA, Superfund, Safe Drinking Water, and other responsibilities, we think EPA can clearly do certain things best and most efficiently in this new partnership we envision.

One, EPA can develop and should develop much of the scientific data that can be used by States to set standards that will protect various uses, such as agricultural and industrial uses. States will be in the best position to set those standards, but the information, we feel, can best be gathered in most cases by EPA.

Second, the EPA can help the States to identify and evaluate their ground water resources. In this connection, other agencies, such as the U.S. Geological Survey, certainly have a role as well.

Third, EPA can furnish the best technical data available on cleanup and treatment methods, and on monitoring and analysis methods.

Fourth, EPA can and must provide financial assistance to the States. In our view, this must be substantially beyond current levels where various existing grant programs are, in fact, partially used to help State ground water efforts. In this era, one hesitates to urge significant new Federal expenditures, but I think if you look at the alternatives to State grants, they either do nothing, or involve a major, direct Federal program which itself would cost a great deal of money. So there is simply no easy way out of the fact that if this is the national priority we think it is, there must be Federal money to reflect that.

Finally, we think there is a role for the Federal Government in those relatively few cases where there are truly interstate problems. Some type of arbitration role, we think, would not be inappropriate.

There are other actions that in our view can clearly best be done by the States. The identification and classification of their resources, although with Federal help, really have to be the ultimate responsibility of the individual States.

Second, the States need to use the classifications to set these cleanup priorities, and this would be particularly true where you are dealing with sources of contamination other than the Superfund sites that are covered under the scope of the Federal Superfund law.

Third, the States uniquely must establish the controls on key point and nonpoint sources to prevent harmful contamination. I emphasize that this is a matter that covers a wide variety of sources, many of which will be difficult to develop control strategies for, but that is no excuse for not addressing them.

Finally, of course, there must be compliance and enforcement.

What is our basis for this suggested allocation of responsibilities?

First, when you look beyond the significant Federal legislation already in effect to clean up old waste sites, to prevent new contamination from ongoing waste management activities, most new regulatory measures, in our view, should be State-developed, and will differ perhaps significantly by location and circumstance for four principal reasons.

First, ground water is a highly variable resource.

Senator **Durenberger**. You are going to be fairly brief, Roger, in summarizing?

Mr. **Strelow**. Yes, this is the last paragraph here.

Second, the decisions on resource use are usually based on local factors.

Third, contamination is usually very localized, and in ground water, unlike surface water, very slow moving, so it tends to remain a fairly local phenomenon.

Finally, source controls, including land use factors that must be taken into account, usually have to be custom-designed to fit local circumstances.

Finally, the new partnership that we recommend relies on the States to design and implement regulatory programs, supported and stimulated by the Federal Government. We need a fresh approach, not simply a carbon copy of the earlier Federal/State partnership approaches in other environmental legislation that may well be quite suitable in those cases, for the more homogeneous and areawide problem that they deal with.

We are prepared to support and help develop Federal legislation embodying the sort of new partnership that we believe is critical to achieving better ground water protection.

Thank you.

Senator **Durenberger**. I thank you very much.

The next witness is Mr. Richard O. Austermann, who is the senior counsel for environmental affairs at the AMAX Corp., representing the Western Regional Council.

STATEMENT OF RICHARD O. AUSTERMANN, SENIOR COUNSEL, ENVIRONMENTAL AFFAIRS, AMAX, INC., ON BEHALF OF THE WESTERN REGIONAL COUNCIL

Mr. **Austermann**. You did such a good job in summarizing my testimony, I hesitate to say anything, but I will give it a crack.

The efficient management of water is of enormous importance in the intermountain West, which our organization represents. This part of the country is arid and, to a much greater extent than here in the East or on the west coast, the growth of our agriculture, our cities, and our industry has depended upon the careful development and the efficient use of our scarce water resources, and no less will be required in the future.

As the West has grown and its available surface supplies have diminished, water users have increasingly turned to ground water to satisfy the demands. Because of this dependence, careful management of this resource is essential. The physical supplies need to be protected, and the quality of the water must be maintained so that it remains suitable for existing and anticipated uses.

In short, like everyone else on this panel, we support the proposal that ground water must be protected.

One of the issues before the committee is whether the Federal Government should modify or expand its current role in the protection of ground water quality, and that is what I would like to address here.

We believe that the Federal Government does have a definite role to play in this area, and that some modification of its current role may be required. However, like most of the other panel members, we also believe that the States should retain their primary responsibility for the management and the protection of its resources. We have reached this conclusion for at least four reasons.

First, under western water law, water quantity and water quality concerns cannot easily be separated. This is particularly true for ground water. Since the States are responsible for administering ground water rights, they should also be responsible for protection of the ground water quality. The systems to which I am referring have evolved over many years, and have been designed to take into account and to accommodate competing or conflicting uses.

For example, the aquifer under Tucson, AR, provides water for drinking, for agriculture, for mining, and for stock watering.

States know the variability of their local water resources and variability in use patterns. They allocate rights accordingly.

With respect to transboundary ground water management, in the West, we have substantial experience with interstate compacts, and they have proved to be a flexible management tool, allowing States to accommodate for quantitative and qualitative concerns.

The Western State ground water systems have evolved in numerous ways, and no two are quite alike. However, despite their differences, all of the systems can accommodate water quality concerns, but they do so on a site by site, aquifer by aquifer, and State by State basis.

The second basis for our conclusion is that the protection of ground water quality generally requires the regulation of activities that are not directly concerned with water usage. Like nonpoint source controls under the Clean Water Act, such controls are closely related to land use planning issues. Close coordination among State and local governments is therefore essential.

Furthermore, in the West, where mineral development is prevalent, mining and energy recovery can only be located where these resources exist. Since developments of this sort may require use of an aquifer that is also used for other purposes, some compromise between resource protection and resource use is often necessary. Local interests are best able to strike the appropriate balance to meet their needs.

The third reason for our conclusion is that to a certain extent, the physical characteristics of western aquifers and their recharge areas differ from those in the rest of the country. This is particularly true in the mountains. The aquifers are often small and isolated from each other. We have attached a map to our written statement to point this out.

Also the hydrologic and geologic factors in the arid West contribute to differences in ground water conditions.

Finally, States in the intermountain West have already begun the process of addressing problems of ground water protection. These programs and related Federal programs should be given a reasonable chance to work before another regulatory program is created.

Numerous State and Federal programs to protect ground water have been enacted in recent years, and many others have been updated. Most of them are still in their infancy, and will take time and money for them to be fully implemented.

In conclusion, we believe that States must be allowed to retain flexibility to develop programs that apply to their particular circumstances. Given the diversity of the Nation's ground water resources, use patterns, and laws governing those uses, no single management strategy will do. Different approaches seem to be working in different cases

Thank you.

Senator DURENBERGER. Thank you very much.

Bruce Leavitt, hydrogeologist for the Consolidation Coal Co., representing the American Mining Congress will be our next witness.

STATEMENT OF BRUCE R. LEAVITT, HYDROGEOLOGIST, CONSOLIDATION COAL CO., ON BEHALF OF THE AMERICAN MINING CONGRESS

Mr. LEAVITT. Thank you, Mr. Chairman.

The American Mining Congress appreciates this opportunity to express the mining industry's view on the important subject of ground water protection.

At the outset, the American Mining Congress recognizes that ground water is an important national resource. Ground water is used to supply the water needed by the mining industry to process the mineral ores that are the basic ingredients of the goods in our modern society.

Mining may also affect ground water. To obtain the energy and minerals our society depends on, it frequently is necessary to alter the Earth where nature has deposited the minerals. Just as aquifers have discernible locations, ore bodies are located where nature has placed them, and they must be mined where they have been deposited.

The American Mining Congress, and its member companies, have actively participated in the development of ground water protection and management plans at both the State and the Federal levels. We have presented extensive written and oral information to the Environmental Protection Agency pertaining to its efforts to develop a national ground water strategy. Also, we have testified before congressional committees on proposed legislation to protect ground water.

Individual members of the American Mining Congress have participated in the development of ground water protection plans and programs in a number of States where mining occurs.

Through its involvement in ground water issues, the American Mining Congress has developed a set of basic principles that it believes should be considered in any approach to ground water protection and management. I wish to describe these essential principles here this morning, and urge the subcommittee to consider them in its deliberations.

Any effective ground water scheme must protect the public health and the environment. While it is often important to protect ground water for drinking water purposes, other end uses of ground water must also be recognized and permitted. Groundwater has been and will continue to be used for a multitude of socially beneficial activities. These include, for example, mineral extraction, crop irrigation, and stock watering.

A realistic ground water management scheme must be flexible enough to accommodate these and other uses. Ground water must not be restricted to a single use or to a single protection standard. No single set of controls or quality parameters could apply effectively to all of the Nation's ground water or the multiple uses of that ground water.

Management of ground water for multiple uses, and also for the protection of human health are not inconsistent goals. They should be and can be achieved simultaneously through effective ground water management.

A nondegradation approach to ground water protection and management is unrealistic and is not feasible, especially considering the rapidly advancing pollution detection capabilities. The prohibition of any diminution whatsoever in ground water quality ignores the numerous possible uses of ground water. This position could prohibit many beneficial activities, even those that might affect the composition, but not the utility of ground water. It also does not permit designs which take into account natural attenuation.

Simply mandating zero-pollutant discharge will not make it so. Nor is zero discharge technologically or economically feasible. Congress has consistently recognized the limitations of zero-discharge goals and has acted to control, not prohibit, discharges.

Any Federal legislative consideration of ground water management must keep in mind both the present and historical context surrounding management of this vital resource. Historically, the Federal Government has deferred to State law regarding allocation and use of water. States have held the primary responsibility for managing ground water use within their borders. The occurrence of ground water and its value as a resource vary from State to State and within individual States. The different States have different priorities concerning ground water use and should be allowed to continue managing ground water resources within their jurisdiction accordingly.

Many States are in varying stages of developing ground water management and protection plans to fit identified needs. The American Mining Congress believes that these State efforts should be supported.

It is important to note that ground water is already the subject of Federal protection. Congress has passed several Federal statutes that to one degree or another address the protection of ground water. Federal agencies are in various stages of developing regulatory programs implementing those statutes.

To impose a comprehensive, regulatory-type national ground water program at this point in time would create duplication, waste and, potentially, litigation that would severely hamper both the protection and the management of ground water. Accordingly, the American Mining Congress opposes such legislation.

The Federal Government, nevertheless, does have an important role to play in the protection and management of ground water resources. The Federal Government can and should provide technical and financial assistance, and generally support the role of States in ground water protection.

This role could entail conducting research on ground water problems and developing and disseminating basic scientific information on potential contaminants. Where interstate ground water problems and management issues arise, the Federal Government could assist in developing interstate compacts or other cooperative arrangements.

We believe that EPA's Office of Ground water Protection, working in conjunction with other Federal agencies such as the U.S. Geological Survey, can adequately carry out such a Federal role. The Geological Survey has already amassed a tremendous amount of ground water data and the Office of Groundwater Protection is off to a good start in coordinating the Federal Government's approach to ground water and providing helpful guidance to States. The efforts of these two agencies should be supported and enhanced.

Mr. Chairman, we hope your subcommittee will carefully consider these basic principles that I have enunciated today as you deliberate on the important questions of whether national ground water protection is necessary and, if so, what type of legislation would be most appropriate.

The mining industry wishes to be constructive and helpful to your deliberations and efforts, and will be happy to work with you and your staff in whatever way you deem desirable.

Thank you, Mr. Chairman.

Senator DURENBERGER. Thank you very much. I appreciate that a great deal.

Next is Jack Yost, the president of the Muskegon Chemical Co., representing the Synthetic Organic Chemical Manufacturers Association.

STATEMENT OF JOHN R. YOST, PRESIDENT, MUSKEGON CHEMICAL CO., ON BEHALF OF THE SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION

Mr. YOST. Good morning, Mr. Chairman, and members of the committee, and staff.

SOCMA, so-called, is a group of about 100 companies, half of them relatively small companies under $50 million. My company employs 30 people and has sales of about $3 million. It is a very, very small chemical company.

We believe that ground water is a natural resource having value beyond health, safety, and environmental considerations. It is essential to almost every human activity, and its protection and management should be among the Nation's highest priorities.

I would like to emphasize four key points of SOCMA's position.

One, the primary role should be with State and local government; two, that there is a need to have a scientifically valid data base; three, that this data base should be analyzed in order to set sound criteria for the design of new facilities to protect ground water; and, four, that remedial action for existing problems should proceed stepwise based on risk assessment for the intended use.

First, we believe that the primary roles in ground water protection should be with State and local governments, and this is based on our belief that these jurisdictions possess the best understanding of local requirements which cannot be addressed from the national point of view.

Further, we believe that the appropriate role for Federal programs should be guidance and assistance. The Federal Government could supply guidance in terms of developing ground water protection programs, and assistance on matters relating to complex scientific questions which remain to be solved.

Second, we believe that we must augment our understanding of this resource and the activities which impact upon it. There has been a lot of damage to ground water from a variety of sources, by society at large. By analyzing this, we can develop by hindsight, if necessary, better understanding so that we can both site new facilities in more appropriate ways and design new facilities in more appropriate ways.

We must also realize that actions to correct ground water which have occurred as a result of human activities need to be addressed in an incremental manner. This perhaps is the most important point from the small company's point of view. The resources to do extensive geological investigations are just not there in small companies, and to acquire it is a fantastic expense.

What we should do is go about the problem in a stepwise manner, not to avoid the problem, but to do first the first thing. If that is not enough, then the second thing. If that is not enough, then the third thing. We should do what is necessary to solve the problem, but not mandate some big program that has to happen no matter what the case is.

I think the initial step should be systematic review of existing data for which State and Federal agencies could provide guidance as to where this data is, the information that is available, where it can be found, and how it can be used. This review may be sufficient in itself, or it may serve to identify areas for the next step. The next step digging a few wells, doing this and doing that, but let's proceed on that in a stepwise fashion.

Lastly, whatever remedial action is decided upon, I think it should be decided upon based on: First, the intended use and second, on some kind of a risk assessment that takes into account that intended use. This way we can avoid massive programs that are scientifically pristine, but really don't do a whole lot for us.

In summary, SOCMA supports the protection of ground water quality necessary to maintain appropriate present and future uses. We support a ground water protection management program that calls for a new national ground water study, design, and operation of new facilities to protect ground water quality, addressing existing facilities to understand the impact of ground water quality from inplant manufacture or use of products and a step-by-step mitigation and remedial action to reduce contamination which endangers public health and the environment.

Thank you very much.

Senator **Durenberger**. Thank you very much.

Our next witness is Mr. Scott Cunningham, who is Washington representative of Union Carbide, and is appearing here today on behalf of the Chemical Manufacturers Association.

STATEMENT OF SCOTT CUNNINGHAM, WASHINGTON REPRESENTATIVE, UNION CARBIDE, ON BEHALF OF THE CHEMICAL MANUFACTURERS ASSOCIATION

Mr. CUNNINGHAM. Thank you, Senator.

I appreciate the opportunity to be here on behalf of CMA today, to share our thoughts on ground water policy issues.

Ground water protection should be one of the Nation's highest priorities. CMA member companies use ground water for several purposes and are subject to many Federal, State, and local programs which affect ground water. As a result, CMA has a major interest in protecting ground water as well as the governmental programs which affect ground water. CMA commends the subcommittee's efforts to examine Federal authorities and initiatives available in protecting ground water.

Congress' efforts to address ground water issues, in our view, should focus on helping the States develop and implement their ground water management activities. States should have the responsibility for protecting and managing their ground water resources.

To do so, CMA believes that each State should have a comprehensive ground water management program. Such a program should protect human health and the environment, and provide for the varied uses of the States' ground water resources.

CMA strongly supports the concept of ground water protection. It is clearly preferable to prevent contamination than to restore ground water through cleanup. State ground water management programs should assure that activities are carried out in a manner that reasonably protects ground water quality.

Each State is in the best position to tailor its ground water management program to its own priorities, objectives, and ground water use requirements. Ultimately, it is the State and not the Federal Government that should make the decision on what program elements are best for that State.

An important aspect of a State ground water management program is the method chosen to implement program goals. States are finding classification by use to be a practical and effective management tool, and CMA agrees. According to EPA, 22 States have already adopted or proposed some type of classification system.

Another key element of State ground water management programs, in our view, is development of scientifically sound State ground water quality standards. These standards should form the basis of State ground water protection measures.

A State should set ground water quality standards by designating uses of ground water and using criteria necessary to protect those uses. We think the Federal Government can play a very helpful role here in the development of these criteria.

State management programs can provide a mechanism for protecting particularly sensitive uses of ground water. For example, land use and soils information could be used in conjunction with aquifer mapping to develop a set of highly protective requirements for vulnerable hydrogeological areas such as critical recharge zones.

State programs should have the ability to relate present ground water quality to potential uses. For instance, certain ground waters contain naturally high concentrations of dissolved solids and have minimal value as a source of drinking water. They may, however, be valuable for irrigation and/or industrial uses. This flexibility will help each State set priorities for its management efforts, while protecting all ground water for their appropriate uses.

The ability to derive accurate information about ground water quality through ground water monitoring is an important part of the State management program. It should cover both monitoring networks (for overall data collection) and targeted monitoring (for specific sources or activities). Proper well site selection, construction, sampling, analytical methods, and quality assurance and quality control programs should also be addressed as part of State programs, to provide the basis for making proper decisions.

The Federal Government should continue to assist States to develop and implement their ground water management programs. Technical assistance, and the opportunity for information exchange and financial assistance should be provided as needed to the States, for example, through development of ground water quality criteria.

The Federal Government should encourage and support State classification of ground water by use, and State development of ground water quality standards. Federal assistance should not interfere with each State's prerogative to manage its ground water resources, nor should the Federal Government involve itself in land use decisions, or interfere with or require redirection of existing State programs.

Ground water and land use decisions are of a highly localized nature, responsibility in these areas should continue to reside with the State and local governments. Efforts are already underway to coordinate and consistently administer Federal environmental programs that may affect ground water through implementation of EPA ground water protection strategies. Coordination and appropriate integration with State programs is essential to provide the most effective support to the States in managing their ground water resources.

Thank you, Mr. Chairman.

Senator **DURENBERGER**. Thank you very much.

Our final witness is Kevin McCray, Director of Information Services, National Water Well Association.

STATEMENT OF KEVIN B. McCRAY, DIRECTOR, INFORMATION SERVICES, NATIONAL WATER WELL ASSOCIATION

Mr. **McCRAY**. Good morning.

The 60-person staff of the 37-year-old National Water Well Association represents 9,200 ground water industry professionals throughout the world. These professionals include some of the world's leading hydrogeologists, hydrologists, engineers, contractors, and the manufacturers and distributors of ground water related products. NWWA provides the leadership and guidance for sound scientific, economic, and beneficial development, use, protection, and management of the world's underground water resources.

It is the position of the National Water Well Association's aquifer protection committee that the aquifers of the United States should be protected from unreasonable degradation and contamination. There are aquifers or portions of aquifers where ground water contamination has occurred, or will occur in the future. In some of these places, the contamination will have to be accepted because the situation is irreversible. Therefore, development of water supplies in close proximity must be considered with great care. The development of ground water near these contaminated areas can be approached in the following ways:

Prevention of migration of the contaminated ground water;

Restoration, if possible, of the contaminated portion of the aquifer; and

Restriction of the development of ground water from and near the contaminated zone.

The best and still attainable solution to long-range aquifer protection is the prevention of contamination. The present regulatory requirements and performance standards are well intended, but sole reliance on a list of related requirements is awkward, costly, and partly ineffective. The primary protection of uncontaminated ground water and control of contaminated aquifers will have to come from land-use control at the State and local level.

Land use control includes the limitation of manufacturing, storing, transporting, and/or disposing of harmful materials in aquifer recharge areas. The restriction of the development of ground water from lands overlying contaminated aquifers also may be necessary. Without land use controls, our country's ground water supplies may continue to be contaminated at an alarming rate.

The Federal policies of the present administration are forcing States to assume responsibility for developing ground water protection programs. Therefore, the means, land use control, and the momentum are finally joined. To successfully administer such programs, States must develop an overall planning approach to maximize the limited fiscal and manpower resources available to address these issues.

The focus of such plans should be to minimize the population at risk and to maximize the availability of safe ground water resources. The locations of past and present disposers of waste, the health hazards presented by the wastes, aquifer susceptibility to pollution, and current and projected wateruse patterns should be systematically considered in such a plan. The effective application of land use controls to protect the Nation's ground water resources must consider such factors.

Perhaps one of the most exciting recent Federal initiatives toward ground water protection is one developed from an Environmental Protection Agency project called the DRASTIC process. It is a simple to use and easy to understand methodology for assessing ground water pollution potential of any area in the country. This innovative system was developed through a modified Delphi approach which involved the active participation of 42 of the Nation's leading hydrogeologists.

Hydrogeologic settings are described for different regions of the United States. These settings incorporate the major hydrogeologic factors which affect and control ground water movement, including depth to water table, net recharge, aquifer media, soil media, topography, impact of the vadose zone and hydraulic conductivity of the aquifer. These factors, which form the acronym DRASTIC, are used to infer the potential for contaminants to enter ground water. These settings form the basis for the entire system and create units which can be graphically displayed on a map.

The relative ranking scheme uses a combination of weights and ratings to produce a numerical value, called the DRASTIC INDEX, which helps prioritize areas with respect to ground water contamination vulnerability. The entire system optimizes the use of existing data and provides an evaluation which can be used to direct resources and waste disposal activities to appropriate areas.

These rankings are applied to represent areas larger than 100 acres, thereby making the DRASTIC system an excellent planning and screening tool to assist land use decisionmakers. Hence, what was once an intangible thought process in the minds of experienced hydrogeologists is now a graspable system with outputs which are both visual and verifiable. The DRASTIC system is a fundamental mind-set on how to approach potential ground water pollution problems with logic and confidence.

In conclusion, we, of the National Water Well Association, are convinced that the problems of ground water pollution are first, somewhat less catastrophic than many believe; second, better understood than some are willing to admit; third, manageable with a few exceptions; and fourth, have a special ally that with time allows this temporal concern to be overcome, that ally being mother nature.

While evidence of ground water pollution can be found in nearly every county in America, the volume of water contaminated is amazingly small. We believe that we have yet to pollute 1 percent of our ground water supply. We can eliminate the initiation of new sources of contamination within 10 years and create a public ethic and morality which will put an end to all ill-conceived hazardous material handling practices.

The existing plumes will not have moved much farther or polluted much more. The odds are in our favor to end up with 98 percent of our ground water still unpolluted at the end of this century. We will still be left with decades of work to contain, control, and remove the mess we have been making throughout most of our lifetimes, but it will be seen clearly as a manageable job.

Thank you.

Senator **Durenberger**. Thank you, and I thank all of the members of the panel for their helpful and comprehensive written statements and the brevity of their presentations. I have not had the experience in a while of having seven panelists conform as closely as you all did to our time limitation rule in any committee I have been on. I congratulate you for that, and also for getting your points across in both of those forms.

If appropriate, I would yield to my ranking member if he would like to make an opening statement. Senator Baucus, do you have anything that you want to say now?

Senator **Baucus**. No, you go ahead.

Senator **Durenberger**. Let me begin, and I will take a few minutes to ask a couple of basically generic questions since, as I predicted in my opening statement, there is some agreement here. I don't expect all of you to respond to all of these questions. But, if you think that you have a really good answer, go ahead.

The first issue is, the relationship between the Federal and State Governments on ground water. I would like you to think of the potential sources of ground water contamination. The OTA report that we received at the end of last year named 33 different sources as potential problems. By sources, I mean such things as hazardous wastes facilities, dumps, landfills, surface impoundments, septic tanks, pipelines, pesticides, fertilizer applications, leaking sewage systems, underground storage tanks, deicing salts, oil and gas development, radioactive waste, and so on. I will not name all of them.

Considering that list, tell us, if you could, where you think the State and local governments acting on their own—that is State governments all across this country, from California to Maine, and from Minnesota to Louisiana, and from Washington to Florida—tell us where they have done a good job of regulating a potential source of contamination so that it is clearly no longer a problem?

Are there cases where States went right out on their own, all 50 of them went out, cleaned up one of these major sources of trouble? Can any one of you give me an example or examples of that, thinking about it in terms of those kinds of sources that the OTA report talks about?

Mr. STRELOW. Mr. Chairman, clearly, NEDA doesn't think that that is the case, that a large number of States have yet done a good job. I think there are several reasons for that. I happen to come from a State, Connecticut, where they have probably done about as well as any, but I think that it is a fairly new problem in terms of major public consciousness. Second, it seems to us, from discussions we have had with a number of State officials, that it is often not a case of lack of will, but lack of resources. That is one of the reasons why we feel strongly that there has to be a substantial Federal infusion of funds, as well as substantially increased expenditures at the State level.

So I think the fact that clearly a large number of States have not yet really adequately grasped this problem and dealt with it is not a reason for saying, therefore, they can't do it and they won't do it. I think they need some prodding and they need a lot of assistance, but I think the relatively mediocre track record to date is not a reason to simply say that we immediately have to go to a big Federal program.

Senator DURENBERGER. Is there general agreement on that, or can somebody think of an instance?

Mr. CUNNINGHAM. I was going to add something more in terms of State capabilities. It seems to me that most of the items that you identified are primarily because of land use decisions that have to be made at the local and State level, and that is one of the reasons why CMA believes that decisions on what to do need to be kept at the State and local level.

I think that what States can do and are moving to do is to try to characterize their ground water, understand things like soils information with the assistance of USGS and EPA; getting into the process of aquifer mapping, to try to understand what areas to be most concerned about and why.

If they have this type of information, each State can then better make decisions, not only on what to do if a situation is discovered, but also how to prevent these situations from occurring where there may not be a specific activity there.

So I think part of it is that the skills and the capabilities are being developed, and they are farther ahead in some States than in others, but the opportunities are there to move ahead.

Mr. AUSTERMANN. I think I can come up with one example, although I have to admit, given the scope of the Federal programs, it is hard to find some area that has not been touched.

In eastern Colorado, the aquifers are used primarily for agricultural irrigation. Most of the ground water out there is contained within basins which are covered by management districts under Colorado ground water quantity law which governs water rights.

The major problem in eastern Colorado has to do with fertilizers, pesticides, you name it, seeping back down into the aquifer after application on crops. A number of the ground water management districts within Colorado, on their own and in conjunction with the Colorado Health Department, have begun to develop programs prescribing techniques limiting the application of these substances to begin to address this problem.

Again, it is one of these things that is just getting off the ground, but there is no Federal involvement, no substantial Federal involvement.

Senator DURENBERGER. Any of the rest of you, in the followup question, you are going to have an opportunity to respond to some of these in writing. Maybe you can make a note of the question, and add to it later on.

There are several points in the statements presented today where it is said plainly that the "Federal Government can't regulate ground water like it has regulated air and surface waters." That statement is usually preceded by a discussion that indicates that there is too much variability to the ground water resource for one rule to be effective all across the country.

But, as a practical matter, I don't think the Federal Government does regulate air, and it doesn't regulate surface waters. What the Federal Government regulates is the sources of pollution for those two media. In the case of air, we regulate powerplants and cars, but we don't do much regulating of indoor pollutants. In the case of surface waters, we regulate factories and sewage treatment plants, but we don't do much regulating of nonpoint sources as Mr. Austermann was talking about that problem. The same thing, I think, is true for ground water. Nobody that I know of is proposing that we regulate ground water itself. All we are saying is that we could do a better job of regulating the potential sources of ground water contamination than we are doing now if we had more information and more resources, and so forth.

We already regulate hazardous disposal facilities under RCRA, as someone stated, pesticide applications under FFRA, underground injection by the Safe Drinking Water Act, mining with the Surface Mining Control Program. We will soon be regulating underground storage tanks.

It is true that the ground water problems are varied across the country, but when you get down to actual cases, it seems that a gasoline tank in California is not that much different from a gasoline tank in Maine, and both are a big problem if they are old, rusty, and leaking.

Is there anyone here who wants to tell us that the Federal Government shouldn't regulate tanks, or mines, or nuclear materials, or pesticides, for example?

Is there anyone here who would say that we have gone as far as we can go on regulating specific sources, and that somehow the remaining unaddressed problems are qualititatively different than the ones that we have done in the past?

Mr. YOST. Senator, I would like to kind of speak around the corner to that just a little bit.

One of the things that we are fearful of is the setting of national standards which may have very little relationships, let's say, to the use intended for the ground water. EPA is very good at solving problems in an elephant-like fashion, but sometimes the results of where that elephant treads out in the local communities don't make a lot of sense based on that local condition. That is at least what we mean by not having Federal management of the program.

We think they should have management of the program in the sense of the strategy that is adopted should be managed by the Federal Government and, if necessary, the States prodded and what-not to do it. But there is another aspect that the Feds ought to do, in our opinion, and that is that a lot of the data today really doesn't stand scrutiny from modern day techniques of analytical procedures, and what-not. So you are very hesitant to base massive strategies on data which may or may not be the very best data.

I think the setting of appropriate analytical techniques, and what-not, is certainly an area in which the Federal Government could be a big help, and also, of course, what I will euphemistically call, resource enhancement.

Senator DURENBERGER. Does anybody else want to respond to the question: Has the Federal Government gone as far as it ought to go in regulating specific sources?

Mr. STRELOW. Mr. Chairman, I would reiterate NEDA's view that we support Superfund, RCRA, the other existing Federal programs that are doing quite a bit already to help deal with ground water problems, and we think they should be continued. Where necessary, where there is a gap or a deficiency, they should be strengthened.

When you look at a number of the sources that basically aren't covered, that is when it gets much more debatable whether the Federal Government can do more than provide information on options, taking septic tanks or road de-icing, or something like that. EPA could certainly pull together useful information on alternative control methods, but when you look at how septic tanks may be used, the kind of geology they are found in in one location of the country where they may have a big impact on an important aquifer used for drinking water, another area of the country where they are quite different, and maybe the aquifer is used for quite different purposes, we just think the likelihood that the Federal

Government could efficiently and fairly dictate or determine how those should be controlled is much smaller.

Senator **Durenberger**. We are discussing the definition of regulation, but what I am trying to get at is sort of our role over with, and we leave it to the States now. Last year, we did something on leaking underground storage tanks. We didn't try to regulate the whole thing, but we set up a framework. At least, it was the Federal Government acting with regard to a source and setting up some parameters in which others would also act with regard to that source.

My question was more directed at your trying to help us sort out has the Government gone far enough. Is it your observation that the Federal Government has done everything that it ought to do already with regard to sources of ground water contamination and there aren't any more sources where regulatory activities of any kind ought to be considered?

I am not suggesting by this that a ground water act is necessary in order to have Federal authority. It might be done in some other fashion.

Mr. **Strelow**. What we are saying is that we think the significant sources that can benefit from some type of Federal direction are pretty well covered, and the significant sources that are largely unaddressed are things where we think the Federal role would best be left to technical direction and guidance, but not determining what kind of regulatory strategy would need to be used in a particular local circumstance.

Senator **Durenberger**. I should yield at this point to my colleagues for their questions.

Senator **Baucus**. Mr. Chairman, thank you.

Gentlemen, I can't quite understand why each State should not have a nondegradation policy. It just seems to me that with the costs associated with the cleanup, and because Federal policy does allow nondegradation in certain cases, at least the Nuclear Regulatory Commission seems to, why shouldn't each State have a nondegradation policy?

Does anybody want to tell me why a State shouldn't have a nondegradation policy?

Mr. **Cunningham**. I will try, Senator.

I think, as I mentioned in my statement, the States need to make the decisions themselves on what the appropriate goals should be for managing the ground water resources. I think we have seen, clearly, some States have made the final judgment that that is, at least, the theoretical goal they would like to establish, and then go about the business of trying to manage the ground water resources.

Other States have made the decision that they are going to establish a goal of protecting and managing their ground water, supporting classification by use and the like.

I think the ultimate decision is for the States.

Senator **Baucus**. What if a decision by a State adversely affects people living in adjacent States?

Mr. **Cunningham**. Most of the specific decisions that need to be made, going back to the question about land use, are generally fairly localized in nature. Clearly, there will be some examples of an interstate impact. I think in those cases, the first thing, obviously, those States need to talk to each other and work together. They can always try to develop interstate compacts along the lines, perhaps, of the Great Lakes.

Senator BAUCUS. The problem, as I see it, is that there are some cases where action by some States is not just negligible, de minimis or incidental to another State. There are large aquifers in this country which affect many States No. 1. No. 2, interstate compact commissions are extremely bulky. They are hard to work with. They don't do a very good job, and ultimately a State can overrule a compact commission anyway, it is up to the State itself. So that really is not an answer.

What I am really getting at is why, therefore, shouldn't there be some Federal requirement of a nondegradation policy in every State to get at this question?

Mr. STRELOW. Senator, as I mentioned in my remarks, first of all, where there are situations of interstate impact, which so far have been quite rare with ground water problems for the reasons I mentioned, NEDA certainly would not be opposed to some type of Federal arbitration mechanism where the States are not able to resolve themselves.

I think that it should be an expeditous process, not one that would take a long and complicated time to work out.

With regard to the broader notion of nondegradation, I think that it is much easier for me personally to deal with the concept of prevention. I think there is a broad consensus favoring preventing problems rather than having to clean them up later.

Senator BAUCUS. That is the premise of my question.

Mr. STRELOW. It is just that I don't think that a philosophy and a commitment to prevention necessarily translates into nondegradation, that is no degradation of any resource, regardless of circumstance, regardless of the nature of the activities. Some of the mining activities, for example, may be impossible to do without a certain amount of impact, and the nature of the resource being affected is one that the State has properly determined that it can tolerate some amount of degradation. I don't know why there should be some arbitrary mandate.

Senator BAUCUS. You make a good point. I am not suggesting that it should be arbitrary, or complete. I am suggesting a policy, and a fairly significant policy. There can be a definition of problems, a nonpoint source pollution problem, different use problems.

Still, why shouldn't each State have a fairly strong nondegradation policy?

Mr. LEAVITT. Senator, relative to nondegradation, we have looked at the hydrogeology within the areas that we operate and we cannot see any way in which you can physically achieve nondegradation. From all of the analysis we have done, it is physically impossible, not only from the mining industry's standpoint, but also from agriculture. We are not going to ban the use of highway deicing salts, we are going to minimize it. We are not going to ban septic tanks, we are going to try to make them work better.

If you come out and say, nondegradation, people will interpret that to mean exactly what it sounds like, that we are not going to lower the quality of the water anywhere.

Senator BAUCUS. Is that better than degradation?

Mr. **Leavitt**. Certainly. We are talking here about protection. We want to increase the protection for ground water, realizing that non-degradation is an impossibility.

Senator **Baucus**. I would just encourage us to move in that direction.

Thank you, Mr. Chairman.

Senator **Durenberger**. Senator Burdick.

Senator **Burdick**. Thank you, Mr. Chairman.

I missed the first part of the panel because I was engaged in another committee. There is just one area that I would like to talk about, and maybe you have already done so.

I think that one of the growing problems facing this country is the problem that results from landfill programs, what we used to call the "old dump grounds." Is it a State concern, or a Federal concern?

There are cities that border on navigable streams, that divide States. What is your opinion, is that a Federal question or is that a State question? I am talking about landfills,

Mr. **Yost**. Including toxic waste dumps; is that in your question?

Senator **Burdick**. I would include that, too, yes.

Mr. **Yost**. I will say, from SOCMA's point of view that this is the single most important problem that the chemical industry in this country faces. There is no question about that. I think that it is a national problem. It is everybody's problem.

Mr. **Austermann**. We would say that it is a national problem to a large extent. It has been addressed in CLERCLA, in RCRA for hazardous wastes, for nonhazardous wastes, in a subtitle D of RCRA.

I know the States in our region have all adopted State statute to regulate leachage, migration from nonhazardous landfills, and I know, for instance, in the State of Colorado, we have just had a meeting with the health department last week, and last year they had come out with a brochure listing some of the problems in the State, and this was one of them. The State recently amended its ground water regulations as they relate to landfills, so that the health department is now satisfied that they have the means to address the problem.

To the extent that it is not being addressed, some additional Federal action may be required, but we don't see that in our region.

Senator **Burdick**. Do any of the others have any comments?

I know that it is a growing problem and a serious problem, and I don't think that we can take it lightly. I really think this could well be an interstate problem with State lines, rivers and so forth. I think that this committee has to address it.

Senator **Durenberger**. I will try one or two more questions. Then we are going to have two votes in a row, so I am going to have to adjourn the meeting, and send you the remaining questions in writing to answer.

One part of the water quality approach is the classification process. The EPA ground water protection strategy is based on a classification scheme. As someone said, some States have or are developing their own classification system. When you look at these schemes, the thing that you discover is that no two of them are alike. Some have two classes. One has eight classes.

I wonder if any of you are concerned that by going down this sort of classification path, we are going to end up with no less than 51 different classification systems. My question is, Do we need just 1 national classification system, or can American industry survive with 50 different classification systems? What advice do you have in that regard?

Mr. AUSTERMANN. It would depend, I think. I think in the case of interstate disputes, you may need Federal guidance as to classifications and goals. I would like to point out, though, in our view, there is no magic to the word classification. What we are talking about is good planning, identifying goals, and how we attain them.

The reason that we have some hesitation in supporting a Federal classification scheme is that we believe that by mandating that all ground waters be classified, much in the way that surface waters have been classified under the Clean Water Act, can result in a serious misallocation of resources. The classifications can be extremely controversial and time consuming when you get into them. If you spend a lot of time arguing about the classification of an aquifer where there is no present problem, you may be ignoring a real problem some place else.

Mr. YOST. I don't know how SOCMA feels about this, but just personally, I would certainly support the need for a classification system as opposed to a national classification, and there is a difference.

In other words, you can insist that the States have one, but not say that they should be A, B, C, and D.

Mr. STRELOW. This may sound a little surprising, but my company and those that I previously represented in law practice, I think almost without exception, have actually come to the point where by and large they would favor, in most circumstances of environmental regulation, a good deal more uniformity. They would often prefer to have a single system that EPA would administer because oftentimes State-by-State differences are frustrating to deal with. There seem to be a lot of differences among States without good reason.

It is against that kind of a predisposition, that NEDA has arrived at the conclusion that in this area, dealing with ground water, you really just can't expect to have a single national answer. I think a single classification system, for example, that would serve Connecticut, Florida, and Colorado, is very unlikely to exist. So despite some of the inefficiencies, if you will, and the frustrations that we often go through when we have to go with a whole variety of different systems, we simply conclude that this is the only way that we can reasonably deal with the problem.

Mr. CUNNINGHAM. I think I would agree. I don't think that CMA at this time could support a mandated national classification scheme for the very reason I pointed out, that in our view the States have to make the final decision on what kind of management program is right for their States.

Although CMA would prefer and it believes that States use classification is the better way to go, we don't think that it is appropriate for the Federal Government to mandate any particular approach for the States to follow in implementing their own programs.

Senator **Durenberger**. Let me take it one step further. One part of the classification system, depending on how we are going to end up defining that, is having some standards. We will have national standards for drinking water, but what kind of standards are we going to have or what kind of standards will we have if every State has a different system for classifying industrial water, or some variant on the definition of industrial water?

Won't everybody here at this table be back in saying that you can't survive 50 different standards for your particular industrial category, and trying to get us to establish 1 standard?

How do we address the standard issue? I hear you saying we ought to wrestle with the classification issue and not have a Federal classification, but have a classification system that has some commonality around the country. What is your answer to the standard part of this system?

The States, as I can tell, really don't want EPA to dictate classification systems. They would like them to set some standards in some way, but they don't want them to dictate classification systems. Then what happens when the two potentially come into conflict, or am I seeing conflict where it doesn't have to exist?

Mr. **Yost**. I think there is a difference between being neat and tidy, and accomplishing a result. It is very neat and tidy to have national standards. However, drinking water is one thing, I would support that. But when you get into these multiple uses, the multitude of uses, and to have EPA sitting down here saying: For this kind of industrial use, you ought to have no more than 10 parts per trillion of XYZ. I would absolutely quake in my boots.

Senator **Durenberger**. That is what I am trying to get at. I want to get the quakers out here ahead of time.

Mr. **Austermann**. I would support that. Frankly, I think it conforms with the approach that you outlined, or you focused on, activities and uses, rather than ground water per se.

We think that the Federal regulation of drinking water supplies is perfectly appropriate. It is a public health and safety issue. If you have public drinking water supplies, you need uniform standards, which are the minimum standards necessary to protect the public health. The problem is where you get into other uses.

Mr. **Manger**. Mr. Chairman, I would like to say that in the Water Alliance debating, and in our task force deliberations, there has been a lot of discussion on standards. Even though we advocate primarily at this point, and have been advocating within the task force, an implementation scheme at the local level, there hasn't been any, at this point, elimination of the need for Federal standards, directed at not only protecting human health perhaps, but also looking at protecting the entire ecological system.

I think that it is probably a key that when you are dealing with the Nation, we have to look at the entire Nation. I think that we have not yet said that we need numerical standards, I think we are also looking at technical standards for sources.

Even though we believe, and a lot of the discussion, at least, centers on local quality districts and implementation at the very local level, a lot of discussion we have had has been for a need for some kind of a standard that you can then rely on at the local level or at the State level as to how clean is clean, or as to what degree of health that you have to protect. A lot of the people that we have talked to look to the Federal Government for some kind of a minimum standard to base that on.

Senator **Durenberger**. I am going to have to adjourn the hearings at this point, because of back-to-back votes scheduled on the floor. As I said, we have many more questions. I think we have started to make some progress here this morning, and I would like to keep that up with the help of all of you who are represented here today.

This is a series of questions that are all interrelated that I would like to submit to each of you to respond to as soon as possible.

Thank you all very much. The hearing is adjourned.

[Whereupon, at 11:25 a.m., the subcommittee adjourned.]

[Statements submitted for the record follow:]

TESTIMONY OF
JAMES J. MAGNER
EXECUTIVE DIRECTOR
NATIONAL WATER ALLIANCE

BEFORE THE SENATE COMMITTEE OF ENVIRONMENT AND PUBLIC WORKS
SUBCOMMITTEE ON TOXIC SUBSTANCES AND ENVIRONMENTAL OVERSIGHT
OCTOBER 24, 1985

MR. CHAIRMAN, ON BEHALF OF THE BOARD OF DIRECTORS, AND ALL OF THE MEMBERS OF THE NATIONAL WATER ALLIANCE, I THANK YOU FOR THE OPPORTUNITY TO TESTIFY ON THE SUBJECT OF GROUNDWATER PROTECTION.

WE WOULD LIKE TO COMPLIMENT YOU ON YOUR LEADERSHIP IN CONDUCTING THIS SERIES OF GROUNDWATER HEARINGS, AND WE COMPLIMENT YOUR STAFF ON THEIR THOROUGH EFFORTS TO INCLUDE AS MANY INTERESTED PARTIES AS POSSIBLE AND TO COVER THE WHOLE RANGE OF RELATED ISSUES.

I AM ACCOMPANIED THIS MORNING BY MR. WILLIAM A. THOMAS, WHO IS THE COORDINATOR OF THE NATIONAL WATER ALLIANCE GROUNDWATER TASK FORCE. MR. THOMAS IS WITH THE AMERICAN BAR FOUNDATION.

THE NATIONAL WATER ALLIANCE GROUNDWATER TASK FORCE WAS OFFICIALLY CREATED BY THE BOARD OF DIRECTORS IN JANUARY OF THIS YEAR AND ORGANIZED DURING THE SPRING. THERE HAVE BEEN SIX MEETINGS OF THE TASK FORCE FROM FEBRUARY THROUGH AUGUST. THE TASK FORCE CONSISTS OF 50 NATIONAL WATER ALLIANCE MEMERS FROM ALL OVER THE COUNTRY. A LIST OF TASK FORCE MEMBERS IS ATTACHED.

DURING THAT SEVEN MONTH TIME PERIOD, THE MEMBERS DEVELOPED A SERIES OF DRAFTS OF A STATEMENT OF GENERAL POLICY WHICH THE TASK FORCE REFERS IS REFERRED TO AS A "CONSENSUS STATEMENT." AS THE TITLE IMPLIES, THE CONSENSUS STATEMENT REPRESENTS GROUNDWATER POLICY PRINCIPLES WHICH ARE AGREED TO UNANIMOUSLY.

THIS CONSENSUS STATEMENT, AND MORE SPECIFIC POLICY PROPOSALS, WERE THE BASIS FOR GROUNDWATER DEBATE AT RECENT NATIONAL CONFERENCE HELD HERE LAST MONTH IN WASHINGTON, D.C.: "WATER POLICY: 1985."

MR. THOMAS CHAIRED A PANEL SESSION THAT INCLUDED FIVE MEMBERS OF THE TASK FORCE. HE ALSO CHAIRED A TWO-HOUR WORKSHOP SESSION ON GROUNDWATER THAT WAS OPEN TO ALL CONFERENCE ATTENDEES, WHETHER THEY WERE MEMBERS OF THE ALLIANCE OR NOT.

FROM THE CONFERENCE SESSIONS, A REVISED DRAFT OF THE "CONSENSUS STATEMENT" IS BEING CIRCULATED TO THE NATIONAL WATER ALLIANCE BOARD OF DIRECTORS AND ALL NWA TASK FORCE MEMBERS FOR THEIR COMMENTS AND RECOMMENDATIONS. THIS IS AN ONGOING AND EVOLVING PROCESS THAT WILL INCLUDE A CONTINUATION OF TASK FORCE MEETINGS AND A NATIONAL WATER ALLIANCE GROUNDWATER CONFERENCE TO BE HELD IN COLORADO SPRINGS, COLORADO, APRIL 16 - 18, 1986.

THE BOARD OF DIRECTORS, ACTING ON RECOMMENDATIONS FROM THE TASK FORCES, HAS ALSO CREATED AN "AD HOC" COMMITTEE ON WATER QUALITY STANDARDS. THIS GROUP WILL INCLUDE MEMBERS FROM THE GROUNDWATER, WATER SUPPLY AND WASTEWATER TREATMENT.

INFRASTRUCTURE FINANCE AND DEVELOPMENT, AND PUBLIC INFORMATION AND EDUCATION TASK FORCES. IT WILL ADDRESS THE KEY ISSUES CONCERNING WATER QUALITY AND HOW FEDERAL STANDARDS COULD BE MORE CONSISTENT, AND APPLICABLE TO GROUNDWATER. THIS MEANS ESSENTIALLY, THE QUESTIONS OF "HOW CLEAN IS CLEAN? AND; WHO SHOULD DECIDE?" IT ALSO INCLUDES ALL OF THE IMPLICATIONS OF RISK ASSESSMENT.

IN SHORT, MR. CHAIRMAN, OUR PROCESS IS NOT COMPLETE. IT MAY BE, OF COURSE, THAT A POLICY PROCESS IS NEVER COMPLETE BECAUSE OF EVER-CHANGING SOCIAL AND NATURAL CONDITIONS. HOWEVER, WE HAVE IN A VERY SHORT PERIOD OF TIME, DEVELOPED SOME STRONG POLICY PRINICPLES WHICH WE BELIEVE MAY BE USEFUL TO THE SUBCOMMITTEE IN ITS CONSIDERATION OF GROUNDWATER LEGISLATION.

FIRST OF ALL, THERE IS A TASK FORCE CONSENSUS THAT A NEED EXSISTS FOR A CLEAR AND COHERENT NATIONAL GROUNDWATER POLICY. THE POLICY MUST INCLUDE A FEDERAL, STATE AND LOCAL GOVERNMENT PARTNERSHIP, AND PUBLIC AND PRIVATE SECTORS MUST WORK IN TANDEM. IT ALSO MUST BE CLEAR ENOUGH TO ENLIST AND ACCOMMODATE THE ACTIVE, WILLING PARTICIPATION OF ALL THE PEOPLE IN THE COUNTRY. IT HAS BEEN SUGGESTED BY ONE OF OUR MEMBERS THAT WE BEGIN TO ESTABLISH A CLEAN LAND ETHIC IN THIS COUNTRY. THAT WE TRY TO CHANGE ATTITUDES IN A THROW AWAY SOCIETY AND CREATE A NATIONAL SPIRIT OF PRIDE AND PROTECTION.

THERE ARE A NUMBER OF FEDERAL STATUTES AND REGULATIONS RELATED IN SOME WAY TO GROUNDWATER MANAGEMENT, BUT WE HAVE NO COORDINATED FEDERAL POLICY. THIS LEADS TO FRAGMENTED IMPLEMENTATION OF GROUNDWATER PROGRAMS, WHICH IN TURN REDUCES PUBLIC CONFIDENCE THAT GROUNDWATER IS BEING APPROPRIATELY MANAGED.

THERE IS A NEED TO CLARIFY AND CORRELATE THE VARIOUS LAWS NOW AFFECTING GROUNDWATER. AND A CONTINUING IMPERATIVE THAT ANY GROUNDWATER LEGISLATION ENACTED AT THE FEDERAL LEVEL TAKE INTO CONSIDERTAION, AND NOT BE INCONSISTENT WITH, LAWS AFFECTING SURFACE WATER. AND THERE HAVE BEEN RECOMMENDATIONS FROM OUR PANELS THAT THE EFFECTIVENESS OF THE TOXIC SUBSTANCES CONTROL ACT BE INCLUDED IN THAT CONSIDERATION.

IN FACT, THE INTEGRATION OF RELATIONSHIPS HAS BEEN THE DOMINANT THEME THROUGHOUT THE TASK FORCE DISCUSSIONS.

IN ADDITION TO THE COORDINATION OF GOVERNMENTAL ENTITIES, AND THE INTERDEPENDENCE OF SURFACE AND GROUNDWATER, WE ARE ALSO DEALING WITH THE CORRELATION BETWEEN: GROUNDWATER QUANTITY AND QUALITY; WATER AVAILABILITY AND WATER COST; THE EVOLVING RELATIONSHIP BETWEEN JUDICIAL WATER RIGHTS DECISIONS AND STATE AND LOCAL WATER MANAGEMENT; AND THE BALANCE BETWEEN THIS GENERATION'S NEEDS AND THE NEEDS OF FUTURE GENERATIONS AND OUR MORAL, ETHICAL AND LEGAL OBLIGATIONS TO THOSE FUTURE GENERATIONS.

TASK FORCE MEMBERS HAVE EMPHASIZED THAT QUANTITY, THE REALITY OF A TANGIBLE SUPPLY OF WATER, HAS TO BE THE PRIMARY CONSIDERATION IN ESTABLISHING A GROUNDWATER POLICY. THE CONTINUED AVAILABILITY OF A USABLE WATER SUPPLY IS THE DOMINANT ELEMENT IN ANY WORKABLE GROUNDWATER POLICY, AND THIS REQUIRES ATTENTION TO BOTH QUANTITY AND QUALITY. ANY DISCUSSION OF GROUNDWATER SUPPLY HAS LITTLE MEANING WITHOUT CONCURRENT CONSIDERATION OF THESE INTEGRATED CHARACTERISTICS.

IT IS ALSO EMPHASIZED THAT THE PRIMARY GOAL OF ANY NATIONAL POLICY MUST BE PROTECTION. THEREFORE, THE PRIMARY CONSIDERATION AT ALL LEVELS OF GOVERNMENT MUST BE THE PROTECTION OF AQUIFERS FROM BOTH DEPLETION AND CONTAMINATION. DEPLETION OF MANY TYPES OF AQUIFERS CAN RESULT IN SEVERE ECONOMIC STRESS THAT IS NOT NECESSARILY RESTRICTED TO LOCAL AREAS. IT ALSO CAN RESULT IN PERMANENT HYDROLOGICAL AND ENVIRONMENTAL DAMAGE DUE TO SURFACE SUBSIDENCE, SALTWATER INTRUSION, REDUCED STREAMFLOWS, AND DIMINISHED WETLANDS. LIKEWISE, CONTAMINATED GROUNDWATER CAN BE A MAJOR FACTOR IN REDUCING THE SUPPLY OF AVAILABLE WATER. THE COST OF TREATING OR RECLAIMING CONTAMINATED GROUNDWATER FAR EXCEEDS THAT OF DEALING WITH COMPARABLE SURFACE WATER CONTAMINATION, AND THE TIME REQUIRED MIGHT BE MEASURED IN TERMS OF HUMAN GENERATIONS.

BECAUSE OF HISTORICAL AND LEGAL PRECEDENTS, AND BECAUSE OF A GREAT VARIANCE IN HYDROGEOLOGIC CONDITIONS, THE TASK FORCE

BELEIVES PRIMACY IN MANAGING GROUNDWATER MUST BE MAINTAINED AT THE STATE AND LOCAL LEVELS. THIS, HOWEVER, DOES NOT PRECLUDE A FEDERAL ROLE OR RESPONSIBILITY. BUT THE PRINCIPAL ACTION WILL HAVE TO BE AT THE LOCAL LEVEL. IT IS THERE THAT THE DIRECT RESPONSIBILITY FOR THE MANAGEMENT AND PROTECION OF THE GROUNDWATER RESOURCE BEGINS. AS ONE OF OUR PANELISTS STATED: CLEARLY THE RELATIONSHIP BETWEEN LAND USE AND GROUNDWATER QUALITY, ARE INESCAPABLY LINKED. AND THE POWER TO CONTROL LAND USE ACTIVITIES IS GENERALLY HELD AT THE LOCAL LEVEL AND RARELY DOES THE FEDERAL GOVERNMENT OR EVEN THE STATE GOVERNMENT, BECOME INVOLVED IN THIS KIND OF ACTIVITY.

ONE POLICY IMPLEMENTATION STRATEGY AT THE LOCAL LEVEL WE HAVE DISCUSSED IS THE CONCEPT OF SPECIAL WATER QUALITY DISTRICTS. THIS CONCEPT IS ATTRACTIVE BECAUSE IT CAN CREATE A PARTNERSHIP OF STATE AND LOCAL GOVERNMENTS. FOR EXAMPLE, NEW YORK STATE USES WATER QUALITY DISTRICTS TO ADDRESS THE NEEDS OF OWNERS OF CONTAMINATED PRIVATE WELLS. THEY HAVE CREATED AN AUTHORITY THAT CAN RECEIVE STATE AND FEDERAL MONEYS AND ASSIST A COMMUNITY TRYING TO REMEDIATE A LOCAL SITUATION.

A LOCAL DISTRICT IS CLOSEST TO WHERE LAND USE AND ZONING DECISIONS ARE MADE, AND IT CAN MAKE DECISIONS BASED ON LOCAL HYDROGEOLOGIC, SOCIAL AND ECONOMIC CONDITIONS.

AS IN NEW YORK, IT MIGHT ALSO BE A MECHANISM TO ASSIST IN CLEAN-UP AND HELP INDIVIDUALS WHO HAVE BEEN DAMAGED IN SOME WAY. SUCH DISTRICTS OF COURSE NEED NOT DUPLICATE CURRENT LOCAL ENTITIES AND COULD HAVE THE ADVANTAGE OF DEVELOPING A STATEWIDE AND PERHAPS NATIONWIDE NETWORK FOR THE EXCHANGE OF INFORMATION AND TECHNICAL ASSISTANCE. THEY WOULD BE DESIGNATED BY A STATE AND LOCAL COOPERATIVE EFFORT, AND COORDINATED PERHAPS BY A LEAD AGENCY DESIGNATED BY THE STATE.

CONCERN WAS EXPRESSED THAT "POLLUTION HAVENS" NOT BE CREATED, AND THAT STATE AND FEDERAL ROLES BE DETERMINED TO LIMIT THAT POSSIBILITY.

WHILE THE TASK FORCE HAS NOT YET DEALT WITH SPECIFICS, A STATE RESPONSIBILITY WOULD INCLUDE COMPREHENSIVE PLANNING FOR STATEWIDE PROTECTION OF THE QUALITY AND QUANTITY OF GROUNDWATER AND SURFACE SUPPLIES. THIS WOULD CONSIST OF A SHORT AND LONG TERM PLAN, AND INCLUDE COORDINATION AND MONITORING. THE LOCATION AND MAPPING OF AQUIFERS AND IDENTIFICATION OF CRITICAL RECHARGE AREAS WOULD ALSO BE A PART OF THE PLAN. THE STATE, OF COURSE, WOULD HAVE THE OPTION OF IMPLEMENTING AND ENFORCING STATE STANDARDS AND PROGRAMS.

THE FEDERAL ROLE IS ALSO BEING DEBATED. BUT THERE IS GENERAL AGREEMENT THAT, CURRENTLY, GROUNDWATER IS TREATED PIECEMEAL IN RCRA, SUPERFUND, SAFE DRINKING WATER ACT AND OTHER LEGISLATION. IT IS BELIEVED ONE OF THE MOST IMPORTANT THINGS THAT WE HAVE TO FACE AND COME UP WITH IS A WAY TO COMPREHEND AND

INTEGRATE ALL THESE VARIOUS PROGRAMS WHERE GROUNDWATER IS SECONDARY IN CONSIDERATION. AN OVERALL EFFECTIVE PROGRAM TO CONSERVE AND MAINTAIN THE PURITY OF OUR GROUNDWATER SUPPLY MUST BE CONSIDERED. THE FEDERAL GOVERNMENT'S IMPACT SHOULD BE SUPPORTIVE OF EDUCATION, GRANTS TO DEVELOP MANAGEMENT PROGRAMS, AND TO DEVELOP STANDARDS, OR GUIDELINES FOR STANDARDS.

THE FIRST STEP MAY BE TO DEVELOP A COMPREHENSIVE DATA BASE TO EVALUATE HEALTH EFFECTS OF POLLUTANTS. IT WAS PROPOSED THAT THIS WILL BE CRUCIAL FOR ALL LEVELS OF GOVERNMENT IN MAKING BASELINE DECISIONS ON THE ACCEPTABLE LEVELS OF RISK.

THERE HAS BEEN MUCH DISCUSSION ON THE NEED FOR FEDERAL STANDARDS, NOT ONLY DIRECTED AT PROTECTING HUMAN HEALTH, - NOT ONLY FOR DRINKING WATER, - BUT FOR THE PROTECTION OF THE ENTIRE ECOLOGICAL SYSTEM. OUR DISCUSSIONS OF STANDARDS HAVE INCLUDED BOTH WATER QUALITY STANDARDS, (NUMBERS), AND TECHNOLOGY REQUIREMENTS.

A FURTHER CLARIFICATION OF THOSE STANDARDS IS A HIGH PRIORITY FOR THE ALLIANCE. AND AS I STATED EARLIER, THE BOARD OF DIRECTORS, AT THEIR RECENT MEETING, ESTABLISHED A SPECIAL "AD HOC" COMMITTEE ON WATER QUALITY TO MAKE SPECIFIC RECOMMENDATIONS.

ALSO UNDER CONSIDERATION BY THE TASK FORCE IS THE EXTENT OF

THE FEDERAL ROLE IN MONITORING OR ENFORCING COMPLIANCE WITH THOSE STANDARDS AND POSSIBLY SETTING UNIFORM REQUIREMENTS FOR STATE MONITORING OR ENFORCEMENT PROGRAMS.

ANY CONSIDERATION OF COMPREHENSIVE CONJUNCTIVE MANAGEMENT ALSO HAS TO INCLUDE A CONSIDERATION OF CROSS-MEDIA POLLUTION, AND, CONSERVATION AND REUSE MANAGEMENT TECHNIQUES.

WE FIND OURSELVES IN THE FRUSTRATING SITUATION OF CREATING A SOLUTION UNDER ONE REGULATORY SYSTEM ONLY TO CREATE A POLLUTANT OF ANOTHER MEDIUM UNDER ANOTHER SYSTEM. WE CAN NOT CONTINUE TO SIMPLY KEEP MOVING POLLUTION AROUND. AND WE HAVE TO ADDRESS NON-POINT AS WELL AS POINT SOURCE POLLUTION. THIS IS AN AREA WHERE A COORDINATION OF FEDERAL REGULATORY PROGRAMS AND COMPREHENSIVE COORDINATION, PLANNING, AND SUPPORT FOR FEDERAL AND NON-FEDERAL RESEARCH WILL BE IMPORTANT.

IN TERMS OF CONSERVATION, RECENT FEDERAL AND STATE JUDICIAL DECISIONS FINDING WATER TO BE A COMMODITY IN INTERSTATE COMMERCE MAY BE ONE OF THE STRONGEST INCENTIVES FOR LONG-RANGE EFFECTIVE PLANNING. SUCH PLANS MAY BE NECESSARY TO PREVENT OR LIMIT THE EXPORT OF STATE GROUNDWATER SUPPLIES.

THANK YOU, MR. CHAIRMAN, FOR GIVING THE NATIONAL WATER ALLIANCE THIS OPPORTUNITY TO TESTIFY. THE NATIONAL WATER ALLIANCE PROCESS IS NOT COMPLETE AND THE ALLIANCE HAS NOT TAKEN OFFICIAL POSITIONS ON GROUNDWATER RECOMMENDATIONS. THESE ARE

SOME OF THE MAJOR POINTS OF CONSIDERATION, BUT CERTAINLY NOT THE ONLY POINTS OR ISSUES BEING DEBATED. WE DO HOPE HOWEVER THAT THE RECOMMENDATION EMERGING FROM THIS EVOLUTIONARY PROCESS WILL BE HELPFUL TO THE COMMITTEE. AND ALTHOUGH CONSENSUS BUIDLING IS CERTAINLY CHALLENGING FOR ALL PARTICIPANTS, ONE PANELIST RECENTLY SAID, "I MUST SAY THAT THERE ARE REMARKABLE POINTS OF AGREEMENT BETWEEN THE ENVIRONMENTAL COMMUNITY, INDUSTRY, AND STATE AND FEDERAL GOVERNMENT." OUR PROCESS IS OPEN TO EVERYONE AND WE LOOK FOR AGREEMENT ON COMPLEX ISSUES IN A NON-ADVERSARIAL ATMOSPHERE.

WE ARE LOOKING FORWARD TO COMMENTING IN THE FUTURE ON SPECIFIC LEGISLATIVE PROPOSALS, AND OFFER OUR RESOURCES TO MEMBERS OF THE COMMITTEE AND STAFF IN ANY WAY WE CAN BE HELPFUL.

WE WILL BE HAPPY TO ANSWER YOUR QUESTIONS.

PRESIDENT
Robert E. Cole
PRESIDENT EMERITUS
Thomas A. Young
EXECUTIVE VICE PRESIDENT
Steven B. Hellem
VICE PRESIDENT
Angelo Fusco
VICE PRESIDENT
Harlan T. Snyder
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S. Fred Singer
Fred Smith
George F. Sorn
J.C. Turner
Neal D. Wade Jr.
Casey E. Westell

Statement of

Roger Strelow, Chairman

National Environmental Development Association

Ground Water Project

before the

Subcommittee on Toxic Substances

Senate Committee on Environment and Public Works

October 24, 1985

Thank you for the opportunity to testify before the Subcommittee today on the important issues of ground water and the need for a new commitment to its protection. My name is Roger Strelow, and I am Vice President for Corporate Environmental Programs for General Electric. Today I appear in my capacity as chairman of the National Environmental Development Association's Ground Water Project.

The Project is a coalition of industrial, agricultural and labor interests. The industries represented include food, chemicals, construction, electronics, and petroleum companies. We are users of ground water. Our livelihoods and our future growth depend on the continuing availability of ground water for a wide variety of uses. Many of our members are also regulated to help protect ground water. We believe this gives us a balanced perspective on the issue.

Our views are presented in some detail in a policy statement and written testimony which I am submitting for the record. Today I will simply highlight a few critical points.

Summary and Observations

In our research into ground water issues, we have made a number of observations and reached a number of conclusions. Let me summarize these observations and conclusions:

- Ground water protection programs will require a fundamentally different kind of federal-state relationship than under other environmental laws.

Ground water aquifers are uniquely characterized by the hydrology and geology and other surface and subsurface conditions of particular geographic areas. Contamination problems will differ from place to place even within the same geographic area. The degree to which ground water is needed in an area and for what uses, and the degree to which it contains natural impurities, also vary widely. For these reasons, programs will need to be developed and administered at the state and local level in order to cope with these unique factors. No one set of rules and regulations will apply in these circumstances. This makes groundwater an impracticable subject for regulation by the federal government.

Because of the differences between ground water and air and surface water, the approaches used in other environmental statutes will not work. Those approaches include setting generic nationwide goals, standards and priorities; making centralized decisions about technology; and treating state and local governments as regulated parties rather than partners.

What will work is a new type of partnership that lets federal, state and local governments each do what makes the most sense. State and local governments are in the best position to determine their needs and carry out their own programs. The federal government, on the other hand, should set standards to protect public health, such as nationwide drinking water standards, and it should be the focal point for the development, collection and dissemination of the information the states will need to do their job.

- Use is key in designing ground water management goals.

In addressing goals, I have referred to protecting current and future uses. Use is the key element around which all ground water management programs should be designed.

Unlike air and surface water, not all ground water comes into contact with biological systems. Contaminated ground water can only do harm when it comes into contact with people, plants or animals. It is when ground water is used -- for drinking water, for agriculture or industrial processes -- that the impurities it carries are of concern.

For these reasons, we consider ground water classification by use to be the core of any ground water management program. This is a critical tool, in particular, for setting priorities for cleanup efforts. However, where real problems have been identified, we should not wait until a classification system is in place.

- Federal legislation is needed to assure that the states have the financial and technical resources they need.

The single most critical element required for the protection of ground water is adequate resources, both financial and technical. There are various studies by the governors and others now going on, and I am sure that they will confirm this point. While the states should increase the resources available for ground water management programs, we realize that not all of the states will be able to do an adequate job on their own. The federal government must increase substantially the technical and financial assistance it gives to the states.

- Education will be a key part of ground water management efforts.

In addition to the resources, the states will need the political will to do what is necessary. We believe that aggressive education efforts should be started to inform the public of the importance of ground water, the sources of contamination and what can be done. Once the public becomes aware of problems and their causes, political support for ground water management will allow the states to be more aggressive.

The federal role in developing the data needed to inform the public on these issues will be critical.

Education will also be needed to assure that the public and decision-makers design programs based on a better understanding of the uniqueness of ground water.

At the state and federal levels, there are numerous programs that, directly or indirectly, address ground water problems. The Safe Drinking Water Act, RCRA, Superfund and other federal programs dedicate large parts of their resources to what are essentially ground water issues. These programs collectively and individually will go a long way in preventing future contamination of ground water and cleaning up ground water that threatens public health. A lot is being done. As Congress considers new legislation, it should avoid disrupting these programs or creating duplications, confusion and inefficiency with new federal regulatory requirements.

Finally, I think the rising public and Congressional concern about ground water contamination needs to be put in perspective.

Ground water contamination is a serious problem in many areas. Without more informed, and in some places, more aggressive management, the problem will grow. That would be unacceptable. We favor prompt, responsible action, not in a crisis atmosphere -- which would be unwarranted -- but with dedication and, we hope, a strong partnership among the public and private parties concerned.

The following is more detail on our policy statement.

Ground Water Management Goal

The NEDA Ground Water Project recommends that the goal of ground water management programs should be the protection of present and projected uses of ground water aquifers and recharge areas, and the use of appropriate remediation or mitigation measures where contamination has occurred.

Ground water aquifers are uniquely characterized by the hydrology and geology and other surface and subsurface conditions of particular geographic areas. For this reason, ground water cannot be regulated by the federal government in the same manner as we currently regulate surface waters and the ambient atmosphere, whose dynamics are more integrated and predictable over broad geographic areas. In addition, natural contamination by salts and minerals, in addition to human activity, are localized conditions requiring case-specific management decisions. Other local conditions such as the quantity of ground water, and the potential risk to people and the ecosystems because of exposure to ground water, should be important factors on which management of the resource is based.

Public Education

We must become more knowledgable about the unique physical characteristics of our ground water resources to manage the resource effectively. The public, as well as government regulators and legislators, must also be made aware that ground water can be contaminated by a number of human activities. For example, domestic and residential sewage and waste disposal practices, as well as industrial contamination can threaten the resource. In some regions of the country, agricultural and pesticide applications, along with application of de-icing salts during the winter, should be better managed to protect vulnerable aquifers.

While we still have a great deal to learn about ground water in some areas of the country we unfortunately cannot wait for more data or better analytical methodologies before we act to protect and manage the resource. What we already know about ground waters' characteristics suggest caution, however, in mandating federal regulatory solutions analagous to those in existing environmental statutes. This resource requires much more flexibility in tailoring initiatives and solutions that will protect and repair damage to the resource.

Management

The NEDA Ground Water Project believes that states must aggressively assume the leadership role in managing ground water. Based on local needs, ground water management programs should be comprehensive.

In our Policy Statement, we have discussed a variety of mechanisms that we believe states might use to manage their groundwater. These include:

- criteria for drinking water and other uses;
- aquifer classification procedures;
- use designation procedures and criteria for aquifer segments;
- controls on point and non-point sources through discharge limits, permitting requirements and best management practices; and
- where necessary, special controls over critical aquifers and recharge zones.

The mix of such program elements selected should be based upon a community's particular needs and the vulnerabilities of the ground water in question. Such management elements need to be backed up with adequate state and local enforcement and compliance mechanisms, as well as with a commitment of state and local technical and fiscal resources.

Several elements of these programs deserve emphasis. Most importantly, the NEDA Ground Water Project recommends that ground water management directives be based on the designated or likely future uses of ground water. Classifying aquifers by use requires the development of better inventories of available ground water supplies, their quality, susceptability to contamination, and present and projected use.

The Project recommends that decisions concerning the remediation and mitigation of ground water which has been contaminated should continue to be made by federal and state officials on a case-by-case basis with reference to the best available scientific knowledge and currently available technological options for remediation. Clean-up and mitigation decisions should be directed at restoring ground water to suitability for its designated or intended future uses, employing public and private resources on a prioritized basis.

The NEDA Ground Water Project also believes that it is imperative that better coordination among existing and new protection and remediation programs addressing ground water be provided. Numerous current environmental regulatory programs deal expressly with the protection and remediation of ground water from industrial sources. Other potential sources of contamination of equal or greater impact in certain geographical areas are uncontrolled. Simply adding another layer of regulation, however, will not necessarily resolve these inconsistencies or address these shortcomings, particularly if such regulation focuses only on industrial activities.

Need for Federal Legislation

The NEDA Ground Water Project believes that legislation to strengthen and focus certain federal and state activities would be appropriate. The Project does not recommend passage of ground water legislation imposing new federal regulatory requirements to accomplish these management goals. We see no evidence that more federal regulatory legislation is needed. Ample statutory authority to deal with federal concerns already exists. However, it is clear that state and local governments cannot manage ground water properly without technical and financial assistance and support from the federal government. The Project, therefore, recommends that the Subcommittee provide for federal support:

- To develop and implement ground water classification systems;
- To provide the technical information needed for ground water management decisions; and
- To coordinate existing federal, state and local programs.

Congress should assure that such assistance is authorized and encourage coordination among programs.

Federal involvement in the management and protection of ground water should provide for:

- Standard setting for drinking water;
- Ground water remediation under existing laws;
- Criteria for the development of ground water standards for designated domestic and other industrial and irrigation uses;

- Assistance with the evaluation and characterization of ground water resources;

- Methodologies for ground water monitoring, sampling, modeling and clean-up;

- Assistance in the identification of control technology and clean-up technology applications to ground water management; and

- Arbitration of interstate disputes concerning ground water quality or withdrawal.

Closing

I am delighted to have had this opportunity to present the NEDA Ground Water Project's positions on ground water management to the Subcommittee, and I would be happy to respond to your questions.

CHAIRMAN
Riley S. Miles
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Robert E. Cole
PRESIDENT EMERITUS
Thomas A. Young
EXECUTIVE VICE PRESIDENT
Steven B. Hellem
VICE PRESIDENT
Angelo Fosco
VICE PRESIDENT
Harlan T. Snider
TREASURER AND
CORPORATE SECRETARY
Bruce Harrison
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[illegible] Campbell
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[illegible] B. Friedman
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[illegible] F. Gilde
John W. Graves
[illegible] Haun
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THE NATIONAL ENVIRONMENTAL DEVELOPMENT ASSOCIATION'S GROUND WATER PROJECT

STATEMENT OF POLICY AND RECOMMENDATIONS

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I. Executive Summary

The National Environmental Development Association's Ground Water Project (NEDA/Ground Water) is a coalition of industry, agriculture and labor -- users of ground water as well as members of the regulated community. As such, NEDA/Ground Water believes that ground water management should be a national priority, supported by the federal government, but carried out on a state and local basis.

Contamination of underground water supplies is serious in some areas. However, it is not a nationwide environmental crisis. There is a need for new protective or remedial measures in some areas. The types of problems, their causes and the measures which will best address them differ across the country. For these reasons, the actual design and implementation of ground water protection or mitigation programs should remain primarily the job of the states and local governments. To support the states and local governments, NEDA/Ground Water endorses increased federal technical and financial assistance.

NEDA/Ground Water does not support the passage of federal ground water legislation which would impose goals on the states, dictate how goals are to be reached or impose new federal regulatory requirements.

Because ground water is so unlike other environmental media, it requires different approaches to the control, prevention and remediation of contamination and to its management in general. To design and carry out appropriate and effective ground water management programs, government, business and the public should carefully consider the unique nature of ground water.

NEDA/Ground Water recognizes that in some areas there are threats to ground water which jeopardize its suitability for domestic, agricultural or industrial use. In these cases, the threat may not permit Americans to wait for better knowledge before they act to protect the resource. Our lack of knowledge should, however, caution decisionmakers who would conclude that regulatory programs similar to existing environmental statutes will necessarily provide the right solution.

The goal of ground water programs should be the protection of present or projected uses of aquifers and their recharge areas. Consequently, ground water management programs should:

1. Use appropriate remediation or mitigation measures based on the designated or likely uses of aquifers;

2. Provide better coordination among existing and new protection and remediation programs; and

3. Emphasize state leadership roles.

4. Increase the state resources allocated to the development of ground water-related professional and regulatory capabilities.

Existing state and federal environmental protection and conservation statutes already assign direct and indirect ground water protection and remediation functions to environmental protection, resource conservation and other agencies. At the federal level, the Environmental Protection Agency administers several programs which directly address ground water protection and remediation such as the Safe Drinking Water Act, Superfund and the hazardous waste and underground storage tank provisions of the Resource Conservation and Recovery Act. Beyond the functions already in the province of federal agencies, NEDA/Ground Water recommends that federal involvement should be limited to providing increased technical assistance to states in standard-setting for drinking water, developing methodologies for ground water monitoring and sampling; collecting and disseminating information concerning new technologies for remediation; and providing forums for the resolution of interstate disputes. Congress should assure that such assistance is authorized.

In managing ground water, private and public resources should be allocated in accordance with a rational system of priorities related to the protection of people and ecosystems. In this paper, NEDA/Ground Water recommends consideration of a number of mechanisms for managing ground water.

II. Introduction

The public and all levels of government are focusing new attention on the need to better protect, conserve and, where needed, clean up this country's ground water supplies. To participate in the public discussion of this issue, the NEDA Ground Water Project has prepared this policy statement and set of recommendations. NEDA/Ground Water is a coalition of industry, agriculture and labor, users of ground water as well as members of the regulated community. Consequently, this policy reflects a balanced perspective of organizations vitally concerned with the continued availability of ground water for agriculture, industrial and domestic uses, and also concerned about maintaining a healthy national climate for economic development.

Our recommendations are intended to reflect the unique nature of ground water as an environmental medium, the many types of aquifers and the various uses for which ground water is needed. They are also intended to provide a framework for the most effective and efficient mix of regulatory and non-regulatory management techniques built on the existing foundation of federal, state and local responsibilities.

This paper is intended to be an initial statement of principles to guide the future work of the Project. Detailed recommendations on the issues raised in this policy statement and more detailed discussions of the technical and policy underpinnings of those recommendations will follow.

III. Overview

Although ground water contamination* should not be characterized as a nationwide crisis, it is a serious problem in some places. To protect or restore ground water for the many uses for which it is needed, NEDA/Ground Water supports a new commitment to improved and more effectively coordinated approaches to the management of ground water resources at all levels of government. These new efforts should build upon, rather than replace or duplicate the existing structure of federal, state and local laws and regulations. Additional technical and financial resources should be allocated to ground water protection and remediation and, where necessary, existing laws may have to be amended in order to assure that the designated or intended uses of ground water are protected.

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* To avoid confusion between naturally-occurring impurities often found in ground water and substances introduced by man, as used in this paper, "contamination" means the presence of pollutants introduced by human activity into an aquifer such that current or likely future uses are impaired. "Pollutant" or "pollution" includes both naturally-occurring substances and those introduced by man.

Ground water management has long been the primary responsibility of the states. NEDA/Ground Water supports the continuation, improvement and expansion of the states' traditional programs for ground water protection and remediation including classification, regulation of discharges, standards-setting, etc. Nevertheless, these programs have not been adequate in some places. The Ground Water Project believes this has been more the result of a lack of resources than a lack of will and that this situation can be improved if, as we recommend, both state and federal resources for ground water management are increased.

The public and decision makers need to be provided with information to better understand the unique nature of ground water as an environmental medium in order to structure more effective management programs. Further, increased public knowledge about the importance of ground water and the threats to it will bring increased public support for ground water management programs.

Efforts are needed not only to increase understanding of the threats to ground water and what can be done to address these threats, but also to enhance understanding of the resource itself. Without data to the contrary, there is a tendency to think of ground water management in terms derived from more familiar media -- surface water and air. There are, however, fundamental differences between ground water and these other media.

Ground water is found throughout the 50 states. Its quality, availability, quantity and usefulness varies greatly from region to region. Some ground water is fresh water, and can accommodate almost any use, including drinking water. However, much of it is saline or contains concentrations of dissolved solids or other impurities that occur naturally. Depending on the nature and concentrations of these materials, and irrespective of human impacts on an aquifer, ground water may, therefore, be unsuitable for any use. In other cases, ground water may be too impure for drinking, but of high enough quality for some agricultural or industrial uses.

Ground water is found in saturated subsurface formations of different types of rock, sand or gravel at depths ranging from a few feet to thousands of feet below the surface. The formations containing water may be insulated from higher or lower subsurface layers or the surface by rock, clay, or other materials that prevent or limit the exchange of fluids among the water-bearing layers, other formations and the surface. These factors affect the natural quality of the water in an aquifer, its susceptibility to contamination and its availability for use.

Generally, ground water travels through aquifers very slowly and much of it reaches the surface only when purposely withdrawn for use. These factors limit the mobility of any pollutants (natural or introduced by man) in ground water and the potential for people, animals and vegetation to be exposed, except when the water is withdrawn for use.

Consequently, ground water contamination is, more often than not, a localized problem that does not cross state lines. Although aquifers themselves may span several states, areas of contamination and the sources of that contamination are far less likely to present interstate issues than air and surface water pollution.

Finally, ground water is a medium in which pollutants (whether introduced by man or nature) are far more restricted in their movement than in surface water or the air, and to which people and the environment are generally exposed only as a function of the use to which the water is or may be applied. These differences between ground water and other media, and the tremendous variety in the type and quality of aquifers and ground water uses, all have direct bearing on what measures are best to manage the resource and where decisions on management are best made.

IV. Recommendations

Recommendation 1: GROUND WATER MANAGEMENT GOALS

The goal of ground water management programs should be the protection of present or projected uses of aquifers and their recharge areas and the use of appropriate remediation or mitigation measures where contamination has occurred.

Discussion.

Because of the unique nature of ground water as a resource and an environmental medium, different management approaches are needed from those used for the protection of air and surface waters. As discussed below, "management" strategies should be based on these unique characteristics. In particular, the ground water remediation and mitigation measures should address risks to biological receptors -- people, animals or plants that would come in contact with contaminants in the water, rather than water quality *per se*.

The protection of human health and the environment would be best accomplished through coordinated management programs which contain regulatory and non-regulatory elements selected on the basis of the characteristics of individual aquifers, or portions of aquifers: their designated uses, location, susceptibility to contamination and the quality and quantity of water they contain.

Recommendation 2: EDUCATION ABOUT GROUND WATER

Government and private sector decision makers and the general public need to be provided with better information to improve understanding of the unique nature of this resource and the threats to it.

Discussion.

Ground water is a unique, less familiar and less understood resource than other environmental medium. The factors which make it different also require management techniques which reflect its special character. Because of this combination of uniqueness and unfamiliarity and the need to develop special management techniques, education should be given a high priority in the development of national ground water policy. In particular information needs to be developed and effectively communicated on the following points:

A. Nature of the Resource. Government, business, and the public need to fully appreciate the unique nature of ground water in order to manage the resource. Although the sources of technical information and analytical techniques may be centralized, a great deal of site-specific decision making is required because every aquifer has unique characteristics which affect the need for, and suitability of, different management techniques. This means that more knowledgeable decision makers, supported by more knowledgeable constituents, are needed around the country.

B. Nature of the Problem. Although human contamination of ground water is a major problem in some areas, the public and governments at all levels must recognize that not all ground water is suitable for use, even in its natural state. Where there is past or potential contamination attributable to human activity, the priority given to prevention or remediation, the methods and levels selected for control or cleanup and the specific management techniques chosen should all reflect knowledge of local conditions and needs.

C. Sources of Contamination. In order to control, prevent, or remediate human contamination of ground water, knowledge about the sources of contamination and their relative contributions to the overall problem is required. Ground water contamination comes from a wide range of human activities: municipal waste disposal, industry, agriculture, urban street runoff, the use of highway de-icing salts, etc. In addition, in some areas the cumulative effect of many individually small sources of contamination (such as residential septic tanks) may be greater than the impacts of major individual sources of contamination.

Ground water management programs must address all significant, or potentially significant, sources of contamination in a region. Failure to address the problem in such a comprehensive way will result in failure to protect the resource. However, which categories of sources are the most significant sources of contamination varies from one location to another.

D. Priorities. To obtain the greatest, most timely, benefits possible, the private and public resources to be used in ground water protection and remediation should be allocated in accordance with a rational system of priorities related to the protection of people and ecosystems. NEDA/Ground Water believes that priorities should be based on the potential for people, animals or vegetation to be exposed to contaminants in ground water. In most cases, the potential for exposure will be a function of the suitability of the water in an aquifer for some use and the likelihood of such use.

Recommendation 3: MANAGEMENT

A. General.

Ground water management programs should:

- Be based on the designated or likely uses of aquifers or segments of aquifers;
- Provide better coordination among existing and new protection and remediation programs;
- Emphasize the states' leadership role in the operation of ground water programs.

Discussion.

Ground water management approaches based on the intended or designated uses of aquifers best reflect the unique characteristics of this resource and the ways in which ground water contamination presents health or environmental risks. Such approaches consequently hold the greatest promise for allocating resources to best reduce or prevent such risks.

Numerous laws at the federal, state and local levels directly and indirectly address the issue of ground water contamination. Because the factors relevant to the selection of ground water management techniques tend to be localized, states are the most appropriate level of government to develop and administer ground water management programs. Nevertheless, as governments at all levels address their ground water responsibilities, they should look to improving coordination among the existing programs and to assuring that any new programs are well coordinated.

Programs should be designed so that, to the maximum degree possible, resources are expended in ways which most directly and efficiently achieve the goals of ground water management.

B. Use Classification and Inventory. In order to design programs based on ground water use, use classification, keyed to the point of use, is required. This in turn requires the development of better inventories of available ground water supplies, their quality, recharge areas, susceptibility to contamination, and present and projected uses, in addition to surveys of sources of actual or potential contamination.

Discussion.

Although comprehensive use classification efforts need not precede all actions to protect or remediate ground water supplies, such efforts should be a major focus of any ground water management program. Without such an effort, long-term protection and clean-up efforts will inevitably have to rely on goals expressed as ambient targets which do not relate well to the actual potential for exposure to people or other biological receptors. Since the potential for exposure is a function of use, better inventories of ground water resources and their uses are needed and should generally be integrated into classification systems.

Classification should not be over-simplified. If classification systems group together uses with widely-varying tolerances for impurities in ground water, resources available for protective programs and remediation will be misallocated.

Once ground water resources are classified, standards for remediation and protection of the resources tied to those uses can be set. These standards should be based on the application of the best available scientific and technical data. Standards borrowed from other programs can be used when relevant to the human exposures or environmental releases associated with an aquifer, or the portion of an aquifer in question.

Because use, and the likelihood and type of exposure, often vary widely for a particular aquifer, the standards should be tied to the point of use.

C. Program Management Elements. Based on local needs, ground water management programs should be comprehensive and should include those of the following elements which promise to provide the greatest benefit:

- Uniform national criteria for ground water used, or likely to be used, as drinking water;
- Aquifer classification procedures and criteria for other uses;
- Use designation procedures and criteria tied to the point of use;
- Controls on point and non-point sources through discharge limits, permitting requirements and best management practices;
- Special controls over critical aquifers and recharge zones;
- Adequate enforcement mechanisms.

Discussion.

The elements needed in a ground water management program will depend on the uses for which an aquifer's water is withdrawn, or is likely to be needed, and the types of sources which threaten to impair those uses.

D. Remediation. Decisions about cleanup and mitigation of ground water contamination should be directed at restoring ground water to suitability for its designated or intended uses. The issue of "how clean is clean?" should be addressed on a case-by-case basis with reference to the best available scientific knowledge and currently available technological options for remediation.

Discussion.

Major factors in clean-up decisions should include:

- The present or intended future use of a particular aquifer (taking into account naturally-occurring impurities which limit use);
- The extent to which ground water has been degraded beyond the relevant use standard;
- The economic and technical feasibility of removing the contamination;
- The feasibility of controlling or eliminating the source of contamination; and
- The availability of other water supplies for the same intended use.

Where ground water contamination impairs or threatens to impair designated or intended uses, appropriate action must be taken to supply current users with water of a quality suitable for the use and to assure, to the extent practicable, that the resource will be available for future users. Containment of the contamination or providing alternative water supplies or surface treatment of ground water supply should be considered as options to mitigate the effect of contamination. Where these strategies are not adequate to assure the adequacy of present and future water supplies for the uses in question, clean-up of the impacted aquifer should be considered.

E. State and Federal Management Roles. The states should retain primary responsibility for managing ground water resources since ground water protection issues are generally defined by localized parameters and conditions.

Discussion.

Factors that impact on ground water such as geography, geology, hydrogeology, climate, industrial and agricultural activities, and population vary from state to state. Ground water contamination sources differ among, and even within, regions. In addition, states have different needs for their ground water, different requirements for protection based on these needs, and different ground water quality. For these reasons, the primary responsibility for designing and carrying out the elements of ground water management programs, discussed above, should remain with the states and local governments. The federal government can play an important supportive role to provide the necessary technical and financial underpinnings for the state and local programs.

Federal involvement in the management and protection of ground water should provide:

- Standards-setting for drinking water;
- Ground water remediation under existing federal laws;
- Criteria for the development of ground water standards for designated domestic and other industrial and irrigation uses;
- Assistance with the evaluation and characterization of ground water resources;
- Methodologies for ground water monitoring, sampling, modeling and clean-up;
- Assistance in the identification of control technology and clean up technology applications to ground water management;
- Arbitration of interstate disputes concerning ground water quality or withdrawal.

A supportive federal role is necessary because of the complexities of ground water contamination and remediation, the sophisticated technical resources and expertise in federal agencies which many states do not have, and data which the Federal Government has or could obtain more efficiently than the states. An appropriate federal role would include providing technical assistance to states on safe levels of contaminants for certain uses and providing technical assistance on ground water monitoring, sampling and on laboratory and analytical techniques.

With regard to ground water management, the Federal Government can provide much needed technical and fiscal assistance to states while leaving regulatory matters and site-specific ground water protection issues to states and local governments where they can be most appropriately addressed.

Recommendation #4: NEED FOR FEDERAL LEGISLATION

Increased federal assistance to the states is needed:

- o To support the development and implementation of ground water classification systems;
- o To provide the technical information needed for ground water management decisions; and
- o To coordinate existing federal, state and local laws.

Congress should assure that such assistance is authorized and encourage coordination among programs.

Comprehensive ground water legislation imposing new federal regulatory requirements on states or individual sources is not recommended at this time.

Discussion.

Much of what NEDA/Ground Water is advocating would place additional fiscal and technical demands on state and local governments. The federal government could best support the development of technically sound and effective ground water management programs by providing support to the states' efforts through grants, the collection of data and the provision of technical support.

Federal involvement should also be designed to avoid duplication of effort among the states in the collection and analysis of data on ground water quality and availability and in the development and evaluation of techniques for assessing, controlling and remediating ground water contamination.

To the degree there are gaps in existing regulatory authorities to accomplish the ground water management goals discussed above, new legislation should be enacted at the state level so that it can be tailored to the regulatory structures in individual states, to the condition of the ground water in that state and to the uses to which the ground water is, or is likely to be applied.

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TESTIMONY
OF THE
WESTERN REGIONAL COUNCIL
ON GROUNDWATER PROTECTION

The Western Regional Council (WRC) appreciates the opportunity to testify on the protection and management of groundwater.

The Western Regional Council is a coalition of western business interests doing business within the Mountain States of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming. It represents the interests of major financial, utility, manufacturing, mining and other enterprises.

The Western Regional Council recognizes the need to effectively manage and protect this nation's groundwater. That recognition is heightened by our western perspective where water is not only a critical resource, but also a scarce resource, particularly in comparison with other regions of the country. Because of this water scarcity in the West, groundwater is of major importance to the West's economy and basic welfare. Western states depend on groundwater to supply 50% or more of municipal water (up to 80% or 90% in some states) and is the primary source of domestic supply for most rural areas. Well over 50% of the West's use of groundwater is for irrigation and the use of groundwater for industrial purposes is increasing (see Attachment A).

Western states have significant interest in and experience with both qualitative and quantitative water management. This perspective and experience in managing scarce water resources is the basis for our position of state primacy when it comes to the development, implementation and enforcement of a groundwater management program. We agree with EPA's findings in their 1984 Groundwater Protection Strategy which recognizes that states should continue to have the "principal role" and the "basic responsibility" for groundwater protection and management.

The Western Regional Council has arrived at this position from both a legal as well as a practical perspective. We believe western states should retain primary responsibility fo groundwater management because of:

- the West's unique system of water rights (prior appropriation doctrine) where water quality and quantity concerns cannot be separated;
- traditional authority of local and state government for most land use activities;
- physical differences of western aquifers;
- demonstrated ability to manage water quality programs in the western states.

1. Western State Water Rights - Prior Appropriation Doctrine.

State laws and regulations govern the allocation of both surface water and groundwater. While there are four basic doctrines of groundwater law; absolute ownership, correlative rights, correlative rights based on reasonable use and the prior appropriation doctrine, western states have generally adopted the prior appropriation system. This system allows the "first in time" user or the first to apply for the water the "first in right" to use it.

Under this western system, groundwater quantity and quality cannot be separated because groundwater quality-related management decisions necessarily affect the quantity of water that is available for a specific use. Simply put, groundwater cannot be regulated without affecting rights to use the water.

Because western states have developed exceptions to this rule, each state's use of groundwater is governed in varying ways. Nonetheless, certain concepts generally apply. For example, return flows are often a requirement of western state water law. Under this concept, a person is entitled to a certain amount of water for a certain use, a percentage of which must be returned to the stream or aquifer for reuse. If an irrigator is required to meet a standard before returning the water to the stream, the treatment can often be consumptive and less water is returned downstream or to the aquifer for other users. The "junior" users right has thus been affected.

The appropriation system of water rights also requires that the water be put to beneficial use. Each state prioritizes those uses, i.e., drinking water, agriculture, industrial, etc. Under a uniform program of groundwater protection, the situation could arise where a discharger to an aquifer is required to protect an aquifer from further contamination by installing a pump and treat system. This requires a discharger to obtain a right to pump the water. However, under state water law he cannot obtain a water right permit unless the water is put to a prescribed beneficial use. While it may not be disputed that the quality of the aquifer should be the most important use, the state system must determine that use in each individual situation, otherwise water right conflicts will result.

As mentioned, in the West while much of the population relies on groundwater for drinking water purposes, the majority of groundwater is used for agricultural purposes and an increasing amount is being used by industry. Any uniform or minimum drinking water standard could require protection of a groundwater aquifer and prohibit degradation to assure its potential as a drinking water source. The state, however, may have allocated the water for a different use allowing for lower water quality. This would place the federal standard in direct conflict with the state water rights system.

State water allocation programs already take into account competing or conflicting uses. As previously stated, the scarcity of water as a resource in the West has required states to become adept at balancing uses. Any specific groundwater aquifer in the West typically serves numerous different water uses. For example, the large aquifer physically located under the City of Tucson, Arizona, provides water for such various uses as human consumption, agriculture, stock watering, irrigation, industrial, mining, etc. It would not be appropriate to ban certain activities which may affect an aquifer on the basis that a portion may be useful for drinking water when, at another location, the same aquifer is not suitable for drinking water. For instance, EPA's groundwater strategy tends to classify the aquifer into one category. They also fail to incorporate local knowledge of resource variability. Many aquifers exist which could fall into a variety of categories and classes depending on the water quality at a particular location. States are best able to plan for these future uses and classify and or manage each aquifer as they see fit. States can and have accommodated the above situations through the evolving water rights process.

With respect to transboundary groundwater management, interstate compacts provide a flexible management tool. The compacts differ depending on the characteristics of the aquifer and the states needs. A few of the factors that must be considered in developing interstate compacts include:

- physical properties of the transboundary aquifer;
- accommodation of differing state legal systems;
- different stages of economic development, thus aquifer development; and
- coordinated regulatory authorities.

States have two major incentives for establishing such compacts; one is quantitative and one is qualitative. A state will not only be interested in establishing rights to an equitable share of the regional resource but the quality of that share maintained at a specific level.[1]

There are numerous ways state groundwater allocation systems have evolved. The important point is that states water rights systems can accommodate water quality and quantity concerns, but they do so on a site-by-site, aquifer-by-aquifer basis. We believe very careful consideration must be given to the western system of water allocation. Otherwise, a uniform regulatory program may only create a complicated and conflicting set of standards that will be ineffectual and, in the long run, only delay groundwater protection in the western states.

2. State and Local Land Use Authorities.

In most cases, groundwater contamination is occuring as a result of activities on the land surface rather than from the actual use of the aquifer. EPA claims a variety of improper waste disposal methods account for a substantial amount of groundwater contamination. These include: abandoned hazardous waste sites, landfills, septic systems and land application--all of which are authorized through local or state land use authorities. It is only at this level of government that the major groundwater contamination problems can be addressed.

State and local laws must take into account risk assessment, competing uses, and management strategies in their decision making process. In the siting of hazardous waste facilities, for instance, such factors are essential in order to provide for the best management of groundwater as a resource and for the protection of human health and the environment. In the West in particular, the states and local governments must retain adequate flexibility to accommodate two very different kinds of facility siting concerns.

a. Considerable siting flexibility. A hazardous waste treatment and disposal site for organic wastes would best be located at an area removed from a population center and situated over an area where several hundred feet of impermeable soil occurs or over an extremely poor quality aquifer. The risk to health from such a facility would be minimal and no groundwater protection measures should be required, except to the extent that adjacent or higher quality aquifers need to be protected.

However, if uniform standards are set to require protection of aquifers, the facility may be required to comply with mandatory protection requirements even though groundwater contamination or degradation may not be physically possible. Given the same design and operational requirements, the facility will no doubt opt to locate near the generators of the waste, even though those generators may be located near populated areas or near a higher quality aquifer. This would offer the greatest risk to the public and be the least environmentally sound option.

b. Limited siting flexibility. In the West, there are facilities which have no choice in their siting and are not amenable to the kind of technology that is normally applied to hazardous waste sites. Mining and energy recovery can only be located where the resources exist. Wastes from their operations could contaminate groundwater since these wastes typically consist of a very small quantity of low toxicity, naturally occuring elements but which occur in large volumes. However, lining practices suitable for chemical disposal sites are not economically nor practically possible. Since minerals and energy development may require use of an aquifer that is also used for other purposes, some compromise between resource protection and use may be necessary. With little flexibility in the laws, they could virtually put an end to such activities, even though the risk posed may be small compared to the economic benefits. Further, groundwater management options are available to effectively prevent harm to human health and the environment and still satisfy the competing needs of a water-scarce region.

3. Physical Characteristics of Western Groundwater.

While numerous aquifers underly much of the Rocky Mountain western states, generally speaking the groundwater system differs from the rest of the country in that the aquifers are smaller (see Attachment B)[2]. The Ogallala Aquifer, which underlies parts of eastern Colorado and Wyoming, is not charactertistic of western interstate aquifers -- most of which are smaller and generally isolated from each other, therefore giving rise to more localized concerns.[3]

Beyond these broad differences, certainly a major reason for flexibility in state and local controls is the fact that groundwater contamination and its impact depend in part on geologic and hydrologic characteristics which vary from state to state and from aquifer to aquifer. Effective management requires recognition of these various factors such as geologic, climatic, biotic conditions which impact both groundwater quality and required groundwater use. For instance, large portions of the West are hydrologically characterized by highly alkaline soils, deep water table aquifers with thick unsaturated zones, high evaporation, and low precipitation rates typical of arid environments. The natural alkalinity of many soils of the Intermountain West can serve in many areas as a natural buffering agent rendering many low pH discharges essentially neutral.

Also, the low precipitation and high evaporation rates common in the western United States reduce the likelihood of leachate formation.

Finally, in many regions, thick unsaturated zones containing areas of rock of low hydraulic conductivity will substantially reduce the risk of contaminant migration into groundwater. Some western aquifers are either contaminated by naturally occurring components or are situated at depths or locations which makes groundwater development for human consumption or agricultural use economically or technically impractical.

Population distribution patterns in the West tend to concentrate intense demand for groundwater resources in very localized regions near major metropolitan areas. Such areas require more intensive management than the majority of very sparsely populated areas where water use is minimal.

Consequently, many natural features of the arid and mountainous West create a natural groundwater protection system. Such conditions require different approaches to groundwater management and protection than for dissimilar hydrologically characterized regions in other parts of the country.

4. Western State Groundwater Quality Programs.

Because of the practical problems resulting from rapid expansion of population in the southwestern states and the surge in the '70s for energy resource development, western states have had to effectively deal with ballooning demands on their scarce water resources. Demands on the use of groundwater have increased along with demands for quality control to meet the need for new drinking water supplies. As a consequence, western states have been active in recent years in expanding their groundwater management programs.

All of the western states have adopted laws with authority to protect groundwater. These laws differ depending on the particular conditions in that state, and many states are evaluating and revising their programs in view of evolving needs. Some of the basic provisions shared by the western states in their groundwater management programs focus on preventative measures which include:

- regulating the construction and operation of water wells;
- controlling the collection, treatment and disposal of wastes;
- establishing effluent limits or groundwater standards;
- requiring degrees of monitoring;
- protecting recharge zones.

State programs differ with regard to the classification of aquifers, types of standards used and specific requirements for discharges. States also have authority under various federal laws to protect groundwater resources. These include the Clean Water Act, the Safe Drinking Water Act, the Resources Recovery Conservation Act, Superfund, NEPA and Uranium Mill Tailing Control Act.

Attachment C is a brief summary of the groundwater programs in each of the western states.

FEDERAL ASSISTANCE

It is not a lack of existing legislative or administrative authority (either at the state or federal level) that has dictated the degree to which states have developed groundwater management programs. It has been a question of need as well as one of financial and technical ability. In many western states, groundwater pollution problems do not appear to be numerous, although there are site specific concerns. To the extent problems have occurred, state groundwater programs have developed. Of equal importance in the development of state programs is the amount of technical and financial assistance available. EPA's assistance in these areas is crucial to any groundwater protection program. EPA grants to assist states in developing management strategies, monitoring, design controls and assessing potential contamination should be continued. EPA's technical assistance and research in determining health effects of certain pollutants is essential to any groundwater protection program. The efforts of the United States Geological Service are also key in providing hydrogeologic background information and technical assistance to the states.

CONCLUSION

The Western Regional Council believes the states must be given the flexibility to continue to develop programs that apply to their particular circumstances. Given the diversity of the resources and the use of those resources in each state, no single management strategy can be identified as the answer; different approaches appear to be working in different cases. The important goal of any federal or state program should be one of protecting the resource in the best manner possible, not requiring adherence to a system regardless of the consequences. An attempt to apply a uniform, federal system will only disrupt existing, effective state programs.

Western states have responded to the problems of surface water shortages and contamination problems in the past with both creative technical and legal solutions. Groundwater needs from both a quantity and quality aspect pose similar challenges and are being solved. In view of the states responsibility for the allocation of water resources, land use decisions and existing authority for adequate groundwater programs, states should retain responsibility for groundwater management. It is our belief that local and regional solutions are the means for accomplishing effective groundwater protection for the nation overall.

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[1] Western Governors' Association, Interstate Allocation and Management of Nontributary Groundwater, 1984, p. 116.

[2] Ibid., p. 16.

[3] Ibid., p. 17.

ATTACHMENT A

USE OF GROUNDWATER

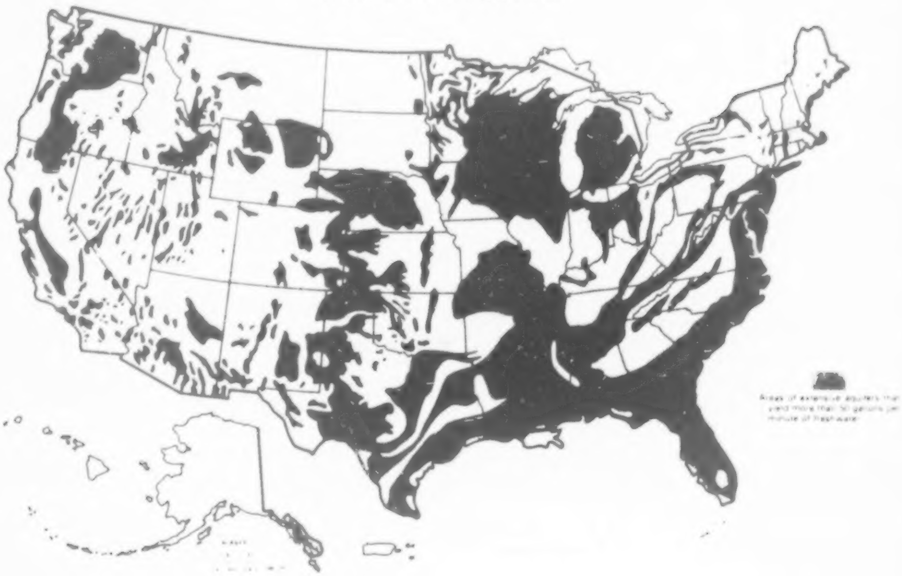
11 WESTERN STATES

	Domestic	Agricultural	Industrial
State	% of Population Using Groundwater	% of Groundwater Used	% of Groundwater Used
Arizona	over 90	80-89	under 10
California	50-59	80-89	under 10
Colorado	20-29	over 90	under 10
Idaho	over 90	50-79	30-39
Montana	50-59	40-49	10-19
Nevada	over 90	50-59	under 10
New Mexico	over 90	80-89	under 10
Oregon	30-39		
Utah	60-69	50-79	under 10
Washington	60-69		
Wyoming	50-59	80-89	under 10

Information obtained from the March 1985, EPA Overview of State Groundwater Programs.

ATTACHMENT B

Major Ground Aquifers in the Nation



GROUND-WATER RESOURCES

Areas of extensive aquifers that yield more than 50 gallons per minute of fresh water

ATTACHMENT C

SUMMARY OF WESTERN STATE GROUNDWATER PROGRAMS

ARIZONA

Groundwater Usage:	Domestic[1]	- 9%
	Agricultural	- 89%
	Industrial	- 2%

For a state with high projections for population growth and very real limitations on the availability of water, adequate protection and planning the use of groundwater is essential. Arizona's 1980 groundwater policy ties quantity and quality together. While the Act was adopted to control depletion of water resources in four highly populated and highly active management areas, the state has also developed groundwater quality permitting regulations and groundwater quality standards.

Facilities are required to submit a discharge plan for all activities which may effect groundwater. This is part of the permit system which requires monitoring, contingency and post-closure plans if there are possible effects on groundwater quality. Mitigation of past impacts and binding schedules to bring a facility into compliance can also be required. The regulations are applicable to abandoned as well as operating facilities.

Arizona has not adopted an aquifer classification procedure, but under the present law aquifers can be designated for certain uses.

COLORADO

Groundwater Usage:	Domestic	- 2-3%
	Agricultural	- 96%

The Colorado Water Quality Commission is adopting a groundwater protection program intended to control or prevent activities which have potential to impair existing or future beneficial groundwater use, or to adversely impact public health. Both narrative and numerical standards have been set for certain contaminants and regulations are in place for regulating drilling, exploration and production activities in order to protect groundwater.

While the state does not use a groundwater classification procedure, aquifers may be designated for waste disposal, or may be prohibited from such on a case-by-case basis. Various statutes and regulations address groundwater contamination from different sources such as feedlots, landfills and sewage systems. Mining, oil and gas related activities and waste disposal are also regulated to protect groundwater.

IDAHO

Groundwater Usage: Domestic - 2.3%
Agricultural - 65%
Industrial - 33%

The Groundwater Quality Management Plan establishes a classification of the major aquifers in the state based on pollution potential and identifies major categories of contamination. The plan allows for development of groundwater quality standards, monitoring, guidelines for siting, construction and operation of surface impoundments and an aquifer protection plan for the sole source aquifer in the northern part of the state. Under the proposed standards, all identified aquifers are designated as drinking water sources or potential sources, and any discharges into the groundwater must meet drinking water standards. The state proposal also includes a reclassification process based on existing groundwater quality. The state has prohibited the disposal of waste through injection wells and developed siting standards for the land disposal of hazardous waste for groundwater protection.

With respect to interstate quality concerns, Idaho and Washington are cooperating to protect the Spokane-Rathdrum aquifer which flows from Idaho to Washington.

MONTANA

Groundwater Usage: Domestic - 45%
Agricultural - 46%
Industrial - 10%

Montana water quality laws provide for a comprehensive program for the prevention, abatement, and control of water pollution, including groundwater. The groundwater program calls for specific quality standards, a classification system, a permitting program for potential sources of pollution, and a non-degradation policy.

The state has classified groundwater into four categories based on the existing quality and suitability of the water for various purposes. General and numeric standards have been proposed, and point sources will not be allowed to violate these standards. Degradation will not be allowed if the groundwater quality is better than the standards and if the activity proposed could effect the uses of the water.

Certain activities which could pollute groundwater are reviewed and cooperative agreements between agencies are established for coordinating activities that could effect groundwater.

NEVADA

Groundwater Usage: Domestic - 4%
Agricultural - 70%
Industrial - 22%

Nevada's Water Pollution Control Act protects all state waters by developing and implementing plans and programs to reduce or eliminate pollution. Groundwater protection is an adjunct to the state NPDES program. Regulations control disposal of pollutants into wells and oil and gas development through a permit system. Permit limitations are based on the effect of receiving waters and its current beneficial use. Violations of groundwater quality standards require remedial action.

The law specifically prohibits the discharge of any nuclear, biological, or chemical warfare agent or any high-level radioactive waste, as well as any proposed disposal which is in conflict with the state's waste treatment management plan.

NEW MEXICO

Groundwater Usage: Domestic - 9.4%
Agricultural - 85%
Industrial - .1%

Through various water statutes, the New Mexico Water Quality Control Commission has established a comprehensive regulatory program to protect groundwater quality. The state has established a classification system for aquifers, and calls for full protection of groundwater with less than 10,000 mg/L total dissolved solids. There are 35 numerical standards plus a generic "toxic pollutant" standard which defines levels as those available in current scientific literature to protect human health and the environment. A statewide monitoring program includes a survey of all existing data sources.

A discharger must submit a groundwater discharge plan which sets forth in detail the methods or techniques he proposes to use. The plan requires monitoring, reporting requirements as well as closure plans.

UTAH

Groundwater Usage: Domestic - 24%
Agricultural - 67%
Industrial - 10%

The state has adopted a comprehensive Water Pollution Control Act which includes protection of groundwater. Standards have been set for protecting sources used for drinking water purposes. The state has a system of monitoring networks particularly designed for groundwater quality controls.

The state has regulations for subsurface disposal of domestic wastes, underground injection control and surface disposal of brines produced from oil and gas wells. The state also prohibits the disposal of waste through deep injection wells and operates a program to control the disposal of hazardous waste to prevent contamination of groundwaters. Siting guidelines also address groundwater contamination.

WYOMING

Groundwater Usage: Domestic - 10%
Agricultural - 80%
Industrial - 5%

In 1973, the Wyoming Environmental Quality Act was adopted which required protection of the state's resources, including groundwater, whenever the threat of pollution existed. Since then the state has developed a groundwater classification system based on protection of existing and potential uses. Four use categories are recognized with specific water quality criteria established for each use category. In addition, the state has assumed primary responsibility from the federal government for administration and enforcement of the NPDES and UIC programs.

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[1] Domestic includes both municipal and rural water supply systems.

Information sources for western state water quality programs: Western State Groundwater Management, Western States Water Council, October 1982 and EPA State Groundwater Program Summaries, Vol. 1 and Vol. 2, March 1985.

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STATEMENT OF

BRUCE R. LEAVITT
Hydrogeologist
Consolidation Coal Company

on behalf of the

AMERICAN MINING CONGRESS

before the

United States Senate

SUBCOMMITTEE ON TOXIC SUBSTANCES AND
ENVIRONMENTAL OVERSIGHT

HEARING ON

GROUNDWATER PROTECTION

October 24, 1985

Mr. Chairman, my name is Bruce R. Leavitt. I am a hydrogeologist with Consolidation Coal Company. This morning I am testifying on behalf of the American Mining Congress (AMC), a national association of companies that produce most of the nation's supply of metals, coal and industrial and agricultural minerals. AMC has followed with interest the hearings held by this subcommittee on the question of whether national groundwater protection legislation is needed. We appreciate you extending us the opportunity to express the mining industry's views on this very important subject.

The approach that you, Mr. Chairman, and your subcommittee have taken to this important issue is the correct one. That is to say, you have properly looked at the issue of a need for a national groundwater protection program by itself on its own merit, rather than as an amendment to some existing statutory program. Also, you have sought the views of a broad cross section of state and local governments and the public.

Groundwater is a vital resource. It is the primary source of drinking water for about 50 percent of our population. Many mining companies use groundwater as a drinking water source, especially in remote locations. Groundwater is also used to supply the water needed by the mining industry to process the mineral ores that are the basic ingredients for most goods in our modern society.
Mining may also affect groundwater. To obtain the energy and minerals our society depends on, it frequently is necessary to alter the earth where nature has deposited the minerals. Just as aquifers have discernible locations, ore bodies are located where

nature has placed them and the minerals must be mined where they are deposited.

Because of the mining industry's interest in groundwater, AMC and its member companies have actively participated in the development of groundwater protection and management plans at both the federal and state levels. For example, we have presented extensive written and oral information to EPA petaining to its efforts to develop a national groundwater strategy. Also, we have testified to congressional committees on proposed legislation to protect groundwater. Individual AMC members have participated in the development of groundwater protection programs in a number of states where mining occurs.

Out of this long-standing interest and involvement in groundwater issues, AMC has developed a set of basic principles that it believes should be considered in any approach to groundwater protection and management. I wish to briefly describe these essential principles here this morning and urge the subcommittee to consider them in its deliberations.

AMC believes that any effective groundwater scheme must protect public health and the environment. While it is often important to protect groundwater for drinking water purposes, other end uses of groundwater also must be recognized and permitted. Groundwater has been and will continue to be used for a multitude of socially beneficial activities. These include, for example, mineral recovery, crop irrigation and stock watering.

A realistic groundwater management scheme must be flexible enough to accomodate these and multiple other uses of groundwater. Groundwater must not be restricted to a single use or to a single protection standard. No single set of controls or quality parameters could apply effectively to all of the nation's groundwater or the multiple uses of that groundwater. Management of groundwater for multiple uses and also for the protection of human health are not inconsistent goals. They should be and can be achieved simultaneously through effective groundwater management.

A nondegradation approach to groundwater protection and management is unrealistic and is not feasible, especially considering rapidly advancing pollution detection capabilities. The prohibition of any diminution whatsoever in groundwater quality ignores the numerous possible uses of groundwater. This position could prohibit many beneficial activities, even those which might affect the composition, but not the utility of groundwater. It also does not permit designs that take into account natural attenuation.

Simply mandating zero-pollutant discharge will not make it so. Nor is zero discharge technologically and economically feasible. Congress has consistently recognized the limitations of zero-discharge goals and has acted to control, not prohibit, discharges.

Any federal legislative consideration of groundwater management must keep in mind both the present and historical context surrounding management of this vital resource. Historically, the federal government has deferred to state law regarding allocation and use of water. States have held the primary responsibility for managing groundwater use within their borders. The occurrence of groundwater and its value as a resource vary from state to state and within individual states. The different states have different priorities concerning groundwater use and should be allowed to continue managing groundwater resources within their jurisdictions accordingly. Many states are in varying stages of developing groundwater management and protection plans to fit identified needs. AMC believes that these state efforts should be supported.

It is important to note that groundwater is already the subject of federal protection. Congress has passed several federal statutes that to one degree or another address the protection of groundwater. Federal agencies are in various stages of developing regulatory programs implementing those statutes. To impose a comprehensive, regulatory-type national groundwater program at this point in time would create duplication, waste, and potentially, litigation that would severely hamper both the protection and management of groundwater. Accordingly, AMC opposes such legislation.

The federal government, nevertheless, does have an important role to play in the protection and management of groundwater resources. The federal government can and should provide technical and financial assistance, and generally support the role of states in groundwater protection. This role could entail conducting research on groundwater problems and developing and disseminating basic scientific information on potential contaminants. Where interstate groundwater problems and management issues arise, the federal government could assist in developing interstate compacts or other cooperative arrangements.

We believe that EPA's Office of Groundwater Protection working in conjunction with other federal agencies such as the U.S. Geological Survey, can adequately carry out such a federal role. The Geological Survey has already amassed a tremendous amount of groundwater data and the Office of Groundwater Protection is off to a good start in coordinating the federal government's approach to groundwater and providing helpful guidance to states. The efforts of these two agencies should be supported and enhanced.

Mr. Chairman, we hope your subcommittee will carefully consider these basic principles that I have enumerated today as you deliberate on the important question of whether national groundwater protection is necessary, and if so, what type of legislation would be most appropriate. The mining industry wishes to be constructive and helpful to your deliberations and efforts, and will be happy to work with you and your staff in whatever way you deem desirable.

I will now be happy to answer any questions you have regarding my statement.

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WRITTEN STATEMENT OF
THE SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION
BEFORE THE
SUBCOMMITTEE ON TOXIC SUBSTANCES AND ENVIRONMENTAL OVERSIGHT
OF THE
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
OF THE
UNITED STATES SENATE

GROUNDWATER PROTECTION POSITION STATEMENT

OCTOBER 24, 1985

INTRODUCTION

The Synthetic Organic Chemical Manufacturers Association (SOCMA) is a non-profit trade association of approximately 100 manufacturers of organic chemicals. SOCMA's members produce approximately 5,000 distinct synthetic organic chemicals, primarily intermediates and finished chemicals for industrial use. Over half of SOCMA's members are considered to be small businesses with annual chemical sales below fifty million dollars.

SOCMA supports the protection of groundwater quality necessary to maintain appropriate present and future uses. Groundwater is a natural resource having value beyond health and environmental considerations. Groundwater is essential to almost every human activity. Its protection and use-management should be among the highest of national priorities.

SOCMA's comments on the Environmental Protection Agency's (EPA) draft groundwater strategy (March 14, 1984) noted the appropriateness of assigning primary roles in groundwater protection and management to state and local governments. This position remains unchanged today. Furthermore, SOCMA stressed that EPA must demonstrate the necessary leadership to coordinate federal programs consistent with the state and local management responsibilities relating to groundwater. This must be done in such a manner so as not to infringe on states' rights, but yet provide the necessary guidance to assist in the development of meaningful groundwater programs from state to state.

All groundwater is not pristine. More than two centuries of human activity, land use, and certain local hydrogeological conditions, such as coastal salt water intrusion, have rendered some groundwater supplies unsuitable for designation for the highest use classification (i.e. drinking water). Some states have effectively dealt with this situation by designating some groundwaters as drinking water supplies and other groundwaters for multiple use applications. Where states have declined to take initiative to develop groundwater management plans, the EPA should provide appropriate guidance for federal decision-making under existing statutes in those states.

SOCMA would like to discuss the four major components of its groundwater protection and management position.

NATIONAL GROUNDWATER STUDY

SOCMA believes that we must augment our understanding of groundwater resources and the activities that impact upon it if we are to develop an appropriate national strategy regarding groundwater use and protection. To increase the knowledge of the groundwater resources, a nationwide effort is necessary to collect, interpret and disseminate groundwater data for utilization in characterizing and designating groundwater uses to facilitate sound protection and remediation decisions.

A great deal more needs to be learned about the natural chemical and biological composition of the groundwaters of the United States. The United States Geological Survey (USGS) has been involved, almost since its inception, in the mapping and characterization of the groundwaters of the country.

However, sporadic funding and other factors have made it difficult to gather all the data that are needed. The data are incomplete. For example, the distribution of synthetic organic compounds in groundwater is poorly understood, and in many cases, one sample in one section of a state may become the basis for characterization of groundwater in large areas of that state. Additionally, a number of major problems need to be resolved, including the development of validated sampling and analytic techniques before reliable data will be available. Therefore, it would seem appropriate to allot additional funding to the USGS to expand and continue their excellent groundwater monitoring program, and to improve our understanding of this valuable resource.

NEW FACILITIES

New facilities and activities should be selected, engineered and operated using appropriate technologies to protect groundwater quality.

Most of the current groundwater problems which have been identified can be attributed to former human endeavors, primarily since the industrial revolution. The remediation of present groundwater contamination from past industrial manufacturing and use practices is addressed elsewhere in this statement. Today, we have an opportunity to preclude the creation of new problems from manufacturing plants now on the drawing boards.

The most assured cost-effective method for preventing groundwater contamination is to prevent it at the source. New facilities should be designed using good engineering practices and appropriate technologies for minimum waste generation and release. Positive containment of release can help prevent the introduction of unwanted substances into the groundwater. Engineers have designed plants which are currently operating with minimal waste discharges to groundwater. Engineered structures to contain and manage human errors and mechanical malfunctions should be designed into all new facilities. Hind-site analysis of past waste management practices should provide sufficient impetus to select, design and operate new chemical processing, storage and handling facilities using proven technology to preclude releases of substances into the soil and to protect groundwater quality.

EXISTING FACILITIES

Existing facilities and activities should be addressed for potential impacts on groundwater quality from in-plant manufacture or use of products, and appropriate actions taken to minimize groundwater contamination which endangers public health or the environment.

It is important that potential groundwater impacts at existing facilities be addressed in an incremental manner consistent with protection of human health and the environment. The initial step should be a systematic review of existing data. Existing facilities should start gathering and reviewing readily available information on the uses and characteristics of groundwater in the area and the types of operations that could affect groundwater. State or federal agencies should provide guidance to small businesses on the type of groundwater information that is available, where it can be found, and how it can be used. This initial review may be sufficient, or it may serve to identify areas where additional data is needed. If further review provides indications of potential adverse groundwater impacts, then more focused hydrogeologic investigations would be appropriate to determine if such impacts are actually occurring, and if so, where and to what degree. The burden on small businesses will be minimized by conducting field investigations in this incremental fashion. Small businesses generally do not have in-house the resources or expertise needed to conduct full-scale hydrogeologic studies.

REMEDIAL ACTION

Necessary remedial actions should be site specific to reduce groundwater contamination which endangers public health or the environment. This should be accomplished in the context of receptor risk assessment and economically viable remediation technology.

Of primary concern to the industrial community is the regulatory position that uniform standards should be promulgated for all physical, chemical and biological systems which have an effect upon the environment. SOCMA members have located their plants in many environmental settings across the country, yet they may be forced to meet a common standard to protect uniform groundwater quality. While not doubting that groundwater contamination has occurred in a number of industrial sectors of the country, it is our position that remediation of the groundwater problems should be site specific and should consider the nature and extent of the receptor community when setting groundwater clean-up objectives. Groundwater quality is certainly variable throughout the country and its ultimate use should dictate the objectives of remediation. Accordingly, SOCMA encourages the development of a strategy which is sufficiently flexible to consider the unique character of individual groundwater resources and to provide for remediation of those resources which pose a danger to public health or the environment.

SUMMARY

In summary, SOCMA supports the protection of groundwater quality necessary to maintain appropriate present and future uses. SOCMA supports a groundwater protection and management program that calls for a national groundwater study, design, and operation of new facilities so as to protect groundwater quality, addressing existing facilities to understand the impact on groundwater quality from in-plant manufacture or use of products, and mitigation and remedial actions to reduce groundwater contamination which endangers public health or the environment.

CMA
CHEMICAL MANUFACTURERS ASSOCIATION

STATEMENT OF
SCOTT S. CUNNINGHAM
UNION CARBIDE CORPORATION
ON BEHALF OF
THE CHEMICAL MANUFACTURERS ASSOCIATION
BEFORE THE
SUBCOMMITTEE ON TOXIC SUBSTANCES AND ENVIRONMENTAL OVERSIGHT
OF THE
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
OF THE
UNITED STATES SENATE

GROUNDWATER POLICY ISSUES

OCTOBER 24, 1985

2501 M Street, NW • Washington, DC 20037 • Telephone 202/887-1100 • Telex 89617 (CMA WSH)

I. Introduction

My name is Scott Cunningham. I am a Washington Representative for Union Carbide Corporation and Chairman of the Chemical Manufacturers Association (CMA) Government Relations Committee Safe Drinking Water/Groundwater Task Group.

CMA is a non-profit trade association whose members represent more than 90 percent of the productive capacity for basic industrial chemicals in this country. CMA member companies use groundwater for several purposes and are subject to many federal, state and local programs which relate to groundwater. As a result, CMA has a major interest in protecting groundwater as well as in the governmental programs which affect groundwater. We appreciate this opportunity to share our thoughts on this important issue with the Subcommittee.

Groundwater protection should be one of the nation's highest priorities. The varied uses of groundwater include drinking water, irrigation water for agriculture, and industrial process and cooling water. Groundwater also can replenish surface waters.

CMA commends the Subcommittee's effort to examine federal legislative, regulatory and policy authorities and initiatives available for protecting and managing groundwater. Congress' efforts to address groundwater issues, in our view, should focus on how to best help the states develop and implement their groundwater management activities. Determining what federal assistance states need and how best to provide that assistance is timely and important. The decisions made by the Congress on how the federal government can best support state efforts--and particularly whether or not to draft new federal groundwater legislation--will help assure protection of the nation's groundwater resources.

II. State Groundwater Management Programs

States should have the responsibility to protect and manage their groundwater resources. To do so, CMA believes each state should have a comprehensive groundwater management program. Such a program should protect human health and the environment and provide for and address the varied uses of the state's groundwater resources. These uses should be clearly identified and characterized so that necessary management decisions can be made.

CMA strongly supports the concept of groundwater protection. It is clearly preferable--and more cost effective--to prevent contamination than to restore contaminated groundwater. Groundwater is affected by human activities on the land surface as well as by natural chemical and physical reactions. Though there are no reasonable means of controlling natural processes, state groundwater management programs should assure that human activities are carried out in a manner which reasonably protects groundwater quality.

Many states have some form of groundwater management program. Many factors can influence the type of program a state may develop. Groundwater is affected by many factors, such as aquifer capacity, location, porosity, permeability, and the nature of any contamination. These factors vary considerably from state to state as well as within each state. In addition, the effect of groundwater use on its quality is important in states where salt water intrusion or other contaminant migration may occur. States must also consider the relationship between groundwater quality and quantity and how this should be factored into their groundwater management programs.

Each state is in the best position to balance these factors and to tailor its groundwater management programs to its own priorities, objectives, and groundwater use requirements. These state programs will have some common elements and some differences, in recognition of the varying nature and uses of each state's groundwater resources. Ultimately, it is the state and not the federal government that should make the decision on what program elements are best for that state.

An important aspect of a state groundwater management program is the method chosen to implement program goals. States are finding classification by use to be a practical and effective state management tool, and CMA agrees. According to EPA, twenty-two states have already adopted or proposed some type of classification system.

In our view, a use-classification approach to groundwater management should:

- recognize existing uses;
- protect future uses;
- consider the occurrence, availability, and chemical and biological quality of the groundwater; and
- make sure that different uses of the same groundwater are compatible.

Such an approach can be based on available information from federal, state, and local agencies including:

- soil type and thickness;
- groundwater occurrence and availability;
- sources of public and private water supplies;
- groundwater quality;
- current uses of groundwater;
- locations of waste disposal areas and other potential sources of groundwater contamination;
- sanitary sewage treatment and disposal practices;
- current zoning regulations;
- alternative surface water or groundwater supplies; and
- future water needs.

Another key element of state groundwater management programs, in our view, is development of scientifically sound state groundwater quality standards. These standards should form the basis of state groundwater protection measures.

A state should set groundwater quality standards by designating uses of groundwater and using criteria necessary to protect those uses. It is critical to the standard-setting process that the criteria be based on scientifically sound data and methodologies that include appropriate risk assessment. We think the federal government can play a helpful role by developing these criteria.

State management programs can provide a mechanism for protecting particularly sensitive uses of groundwater. For example, land use and soils information could be used in conjunction with aquifer mapping to develop a set of highly protective requirements for vulnerable hydrogeological areas such as critical recharge zones. These requirements might prohibit, restrict or tightly control certain waste disposal facilities as well as other activities related to land use that might threaten these critical groundwater resources.

State programs should have the ability to relate present groundwater quality to potential uses. For instance, certain groundwaters contain naturally high concentrations of dissolved solids and have minimal value as a source of drinking water. They may, however, be valuable for irrigation and/or industrial uses. Also, some geological formations yield relatively small amounts of groundwater to wells and, therefore, have very limited use. States may decide to protect such groundwaters in a different manner than they would sources of drinking water. This flexibility will help each state set priorities for its management efforts, while protecting all groundwaters for their appropriate uses.

State programs should also guide restoration of contaminated groundwater. For example, where designated uses of groundwater are impaired by contamination, the program should guide the decisions on whether remedial action is required and how remedial action should be structured to meet designated uses.

Groundwater management decisions should be made based upon an understanding of the quality and characteristics of the resource. Necessary information can be gathered through groundwater monitoring, which generally involves sampling and analysis of water withdrawn from wells. The ability to derive accurate information about groundwater quality is an important part of a state management program.

Characterizing resources and investigating contamination problems may require information not available from existing wells. Therefore, proper siting, installation, and use of new monitoring wells is also part of an overall state monitoring program.

Groundwater monitoring involves a number of steps, including well installation, groundwater sampling, analysis, and interpretation of results. Monitoring must be conducted by well trained personnel in order to render reliable and useable results.

State programs should cover both monitoring networks (for overall data collection) and targeted monitoring (for specific sources or activities). Proper well site selection, construction, sampling, analytical methods, and quality assurance and quality control programs should also be addressed as part of state programs to provide the basis for making proper decisions.

III. Federal Support for State Programs

The federal government should continue to assist states develop and implement their groundwater management programs. Technical, informational, and financial assistance should be provided as needed to the states (for example, through the development of groundwater quality criteria). CMA believes particular encouragement and support should be given to state classification of groundwater by use and state development of groundwater quality standards.

Federal assistance should not interfere with each state's prerogative to manage its groundwater resources. Nor should the federal government involve itself in land use decisions or interfere with or require redirection of existing state programs. Groundwater and land use decisions are of a highly localized nature. Responsibility in these areas should continue to reside with state and local governments.

Efforts are already underway to coordinate and consistently administer existing federal environmental programs that may affect groundwater through implementation of the EPA Groundwater Protection Strategy. Such coordination and appropriate integration with state programs is essential to provide the most effective support to the states in managing their groundwater resources.

Federal technical support to the states can be accomplished through continued use and coordination of existing federal authorities, with modified or additional authorities created by Congress as necessary. Some have suggested new, separate federal legislation which focuses on the broad institutional arrangements and technical and financial support needed to help states establish groundwater management programs. CMA, frankly, has not concluded how this federal support could best be structured or whether existing authorities or new legislation will best help support the states.

IV. Existing Federal Legislation and Programs

Historically, the federal government has played a supportive role in the groundwater area, primarily through programs administered by the U.S. Department of the Interior (especially through the U.S. Geological Survey) and the

U.S. Department of Agriculture (through the Soil Conservation Service). The main focus of these programs has been support of states and individuals in water resources management and agriculture, not in groundwater protection. These programs have not included any federal decision-making role over the uses of groundwater.

The technical assistance, data management and research activities of the U.S. Geological Survey represent some of the most important federal support to state efforts. Their hydrogeologists, chemists, and other technical experts have been an important resource for states in characterizing their groundwater resources and in conducting site-specific investigations.

Federal efforts to contribute to the protection of groundwater have come about through the enactment of the various environmental laws and their implementation by EPA. These statutes address key aspects of groundwater resource management: protecting drinking water sources; preventing contamination of specific sources, particularly those associated with hazardous waste; and performing remedial action where contamination has occurred. The Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and several other federal statutes include provisions to reduce or control discharges which may contribute to groundwater contamination.

* * * * * * * *

CMA is pleased to be able to present this testimony on groundwater policy issues. We look forward to working with this Subcommittee in further sharing our views and recommendations.

national water well association

U.S. SENATE TESTIMONY

of

KEVIN B. McCRAY

on behalf of the

NATIONAL WATER WELL ASSOCIATION
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for

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON TOXIC SUBSTANCES AND ENVIRONMENTAL OVERSIGHT

Washington, DC
October 24, 1985

I am Kevin B. McCray, director of Information Services for the National Water Well Association, Worthington, Ohio.

The 60-person staff of the National Water Well Association represents 9,200 ground water industry professionals throughout the world. These professionals include some of the world's leading hydrogeologists, hydrologists, engineers, contractors, and the manufacturers and distributors of ground water-related products. NWWA provides the leadership and guidance for sound scientific, economic and beneficial development, use, protection and management of the world's underground water resources.

NWWA accomplishes its goals through a variety of interconnected services, including: original research into the various aspects of ground water science; creation and management of nearly 70 professional education programs annually; and the publication and dissemination of the most extensive collection of texts, manuals, periodicals and other materials available on the subject.

More than 50 percent of our drinking water comes from ground water sources, a number that is increasing each year. As a result, attention has increased concerning ground water quality and the activities which impact it. The desire to monitor the quality of our ground water, coupled with precision instrumentation capable of measuring chemical components in parts per billion and even parts per trillion, has uncovered the existence of a diverse suite of objectionable contaminants in our water supplies. Their sources are now recognized as daily human activities that run the gamut of safety (highway salting), religion (human burial), commerce (chemical handling) and the more obvious waste disposal practices.

Rapidly advancing hydrogeologic knowledge is fostering scientific efforts to eliminate or contain contaminants now reaching the nation's ground water. Technology exists today to deal with ground water contamination. The often-heard, "Ground water once polluted is lost forever," is just so much political phrase-making. Today, there are means of containing and rehabilitating contaminated ground water, though they are not inexpensive. Many talented people are actively cleaning up plumes of ground water pollution with little fanfare, while immobilizing others. However, the long-term goal of maintaining a still largely uncontaminated water source must rely on the future prevention of pollution.

America has finally reached its tolerance level for the indiscriminant, ignorant and wrong-headed manner by which we have disposed of industrial waste and applied, stored and transported chemicals these past 40 years. The scaremongering stories of oozing gunk generating disease, chromosomal damage and potential death were the warning flags. Yet, like it or not, excesses have drawn our attention to the mess we have created.

Were it not for their rubbing our noses in it, we might have turned our attention to more mundane affairs of the nation. But we have been forced to look, and in so looking, there are few left among us who cannot be rallied to oppose the continuation of our past stupidity. There are few among us not willing to join the ranks of those who would work to reverse the past through calculated, though costly efforts.

EPA has now begun to lead America out of the garbage pits of our past into a clean and safe future. EPA is guiding us in a direction that will not be significantly altered by any future misguided bureaucratic directive. Clearly, the people have not and will not tolerate it.

There are some basic ways to revise the activities of man in order to lessen the stress on our vast ground water resource. They warrant considerable attention now that the battle to alert America to the hidden tragedy of ground water pollution has been won.

Now is the time to focus our attention on altering the future so it is not a prologue to the past. We can, and we must, learn from our mistakes; and, fortunately, the majority of them allow for basic and successful correction. Most of what is needed is little more than common sense. Upon close analysis society will recognize that it isn't more difficult or ultimately more expensive to create environmental safeguards at the onset of our activities.

It is the position of the National Water Well Association's Aquifer Protection Committee that the aquifers of the United States should be protected from unreasonable degradation and contamination.

There are aquifers or portions of aquifers where ground water contamination has occurred or will occur in the future. In some of these places the contamination will have to be accepted, because the situation is irreversible. Therefore, development of water supplies in close proximity must be considered with great care.

The development of ground water near these contaminated areas can be approached in the following ways:

- Prevention of migration of the contaminated ground water;
- Restoration (if possible) of the contaminated portion of the aquifer;
- Restriction of the development of ground water from and near the contaminated zone.

The best and still attainable solution to long-range aquifer protection is the prevention of contamination. The present regulatory requirements and performance standards are well intended, but sole reliance on a list of related requirements is awkward, costly and partly ineffective. The primary protection of uncontaminated ground water and control of contaminated aquifers will have to come from land-use control at the state or local level.

Land-use control includes the limitation of manufacturing, storing, transporting, and/or disposing of harmful materials in aquifer recharge areas. The restriction of the development of ground water from lands overlying contaminated aquifers also may be necessary. Without land-use controls, our country's ground water supplies may continue to be contaminated at an alarming rate.

The federal policies of the present administration are forcing states to assume responsibility for developing ground water protection programs. Therefore, the means (land-use control) and the momentum are finally joined. To successfully administer such programs, states must develop an overall planning approach to maximize the limited fiscal and manpower resources available to address these issues.

The focus of such plans should be to minimize the "population at risk" and to maximize the availability of safe ground water resources. The locations of past and present disposers of waste, the health hazards presented by the wastes, aquifer susceptibility to pollution, and current and projected water-use patterns should be systematically considered in such a plan. The effective application of land-use controls to protect the nation's ground water resources must consider such factors.

Major causes of ground water pollution in the United States are holding ponds and lagoons. These shallow excavations range from a few square feet to many acres in area and are commonly used to hold oil field brines, municipal sewage and a variety of industrial chemicals. If adjacent ground water is to be protected, holding ponds and lagoons should be prohibited unless it can be shown that an impermeable lining will prevent fluids from leaking from them. In practice, this necessitates an impermeable lining that will stop fluids from leaking.

Other major sources of ground water pollution are sanitary landfills. These are constructed by placing wastes in excavations and covering the material with soil daily; the term "sanitary" indicates that garbage and other materials do not remain exposed to produce odors, smoke, vermin and insects. But even though a landfill is covered, leachate almost certainly forms by the infiltration of rain. Pollution of ground water by landfills can be prevented by proper site location to prevent their use in places where leachate can readily enter ground water reservoirs, by regulation of their construction and operation, and by prohibiting the disposal therein of highly toxic wastes.

Stockpiles and wastepiles are an often ignored source of ground water pollution; they include stockpiles for the storage of salt used for highway snow and ice control. In most instances, it is possible to control or reduce ground water pollution from these sources by providing facilities that eliminate or reduce rainfall infiltration and control surface runoff. Impermeable covers are the best examples.

Effluent from septic tanks, cesspools and privies is of little individual significance, but these abundant devices are important collectively. Ground water pollution by septic tanks can be controlled by regulating their construction and installation. Requirements setting satisfactory subsurface soil and rock conditions and adequate land use regulation, including limitations on the number of septic tanks per unit area, are needed.

Literally thousands of miles of buried pipelines criss-cross the United States. Leaks, of course, do occur, but it is exceedingly difficult to detect them. A growing problem of substantial consequence is leakage from storage tanks and their associated piping. Ground water pollution from this source could be minimized by periodic inspections of tanks and pipelines, including pressure testing, and careful monitoring of fluid levels and inflow-outflow comparisons. Metal tanks can also be replaced with noncorrodable material such as fiberglass.

Hundreds of thousands of abandoned exploratory wells or test holes dot the countryside. Many of these were drilled to determine the presence of underground mineral resources. The open holes permit water to migrate freely from one aquifer to another. A fresh water aquifer could thus be joined hydraulically with a polluted aquifer or a deeper saline aquifer. The only realistic and practical solution to ground water pollution caused by abandoned wells and exploratory holes is timely and adequate well plugging procedures.

Toxic materials are transported throughout the country by truck, rail and aircraft. Accidental spills are increasingly common. No amount of laws and regulations will ever cause accidents to cease, but inspection of transportation equipment, adequate insurance provisions and the placing of damage responsibilities on the hauler can reduce this number.

Animal feedlots cover relatively small areas, but provide a huge volume of wastes. Feedlots should be designed, operated and maintained in such a manner that the liquid runoff is not allowed to infiltrate or flow into streams.

The use of both fertilizers and pesticides is increasing. A reduction in fertilizer application rates and adoption of sediment runoff control measures could reduce ground water pollution. In many instances, the volume of pesticide application can be lowered without reducing its effects. Major advances are now being made in the development of more potential biodegradable agricultural chemicals which require significantly reduced application volumes and do not persist in the soils and ground water below.

In certain situations, pumping of ground water itself can induce significant water quality problems. The principal causes include interaquifer leakage, induced infiltration and landward migration of seawater in coastal areas. Reduction of ground water pumping, water conservation and artificial recharge of ground water reservoirs are partial solutions to man induced water quality problems.

Are the aforementioned solutions unrealistic? No! Can these reforms be implemented quickly and easily? No! Can they be implemented in a period of time shorter than that during which they have plagued us? Yes!

The problem is solvable because after decades of concern, hydrogeologists have successfully pressed for adequate federal control of ground water quality. While the rules of the game are yet to be fully established, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Surface Mining Control and Reclamation Act, the Toxic Substance Control Act and the Clean Water Act can collectively protect all the nation's ground water with regard to today's pollution perils.

Yesterday's problems, of course, are a different story. We are indeed stuck with what has already entered the ground. In fact, we can be sure much more will enter the ground before we eliminate or redesign the activities that currently pollute ground water, a feat probably attainable by 1990.

Our environmental protection program will proceed more effectively when it offers greater flexibility for cooperative relationships between government and industry. Greater flexibility is only possible when regulations and regulatory officials have a higher level of scientific awareness. The government must train and maintain an effective force of technically qualified regulators who can exhibit discretion in an effort to achieve mutual goals.

There are additional causes for optimism that relate less to the physics of ground-water movement and more to man's common sense and his related ability to recognize a problem before he has fully painted himself into a corner. The very wastes which have created our serious ground-water pollution problems these past three or four decades are at last being significantly reduced by some of the industries that were previously among the worst, though largely unwitting parts of the problem. Though few people appear to be satisified with the envrionmental regulatory matrix, intended to serve as a safety net, the bottom line for industry is quickly being perceived as an increasingly high cost for waste disposal. Just as necessity is well known as the mother of invention, economics is the driving force for industrial innovation. Today it is becoming apparent to many industries that it really does make "cents" to reduce the waste stream from every and any plant and factory. Disposal costs and the cost of raw materials are finally forcing plant managers to be innovative. Many have been very successful. A few cases in point:

o U. S. Steel estimates that it has reduced the generation of hazardous waste by nearly 50 percent in the past few years while concurrently reducing its reliance on landfills by as much as 80 percent. Heavy sluge residues that were once discarded by that company are now mixed with tars and converted into fuel. They also substituted nonleaded greases and oils for leaded lubricants in their rolling mills, thus improving the nature of their disposal problem.

o Dupont has begun removing organic chemicals from its waste streams with a new membrane separation technology not previously thought economically possible.

o 3-M Company is saving nearly a million dollars a year in the application of abrasive resins to its sandpaper by creating a continuous feed process that no longer requires the emptying and cleaning of used-up containers of these materials. They reduced cleaning of used-up containers of these materials. They reduced their hazardous waste stream by 400 tons a year in the process.

o CIBA-GEIGY used a similar technique in the manufacturing of dyes that netted it an increased product yield of over 25 percent from its basic raw materials. That same company recently abandoned the use of zinc in its process for making a plastics additive and substituted hydrogen which eliminated the handling of a strictly-regulated hazardous material.

Now that the recognition of existing problems and development of alternate technologies are coming collectively into focus, the nation is ready to establish a long-term strategy to contain and reduce pollution by the end of this century. This goal warrants the highest priority by the appropriate federal agencies and continued attention from the Congress. However, it should be recognized that while ground water's glacially slow movement produces long-term problems, it also affords adequate time to achieve the most reasonable approach of managing them. The legislative program forged over the last decade must be refined and maintained to support the elimination of ground water pollution. Federal initiatives in these areas will make it possible to detect yet undiscovered sources, correct those now recognized, and prevent the future from repeating the past.

Perhaps one of the most exciting recent federal initiatives toward ground water protection is one developed from an Environmental Protection Agency project.

Called the DRASTIC process, it is a simple-to-use and easy-to-understand methodology for assessing the ground water pollution potential of any area in the country. This innovative system was devloped through a modified Delphi approach which involved the active participation of 42 of the nation's leading hydrogeologists.

Hydrogeologic settings are described for different regions in the United States. These settings incorporate the major hydrogeologic factors which affect and control ground water movement including depth to water table, net recharge, aquifer media, soil media, topography, impact of the vadose zone and hydraulic conductivity of the aquifer. These factors, which form the acronym DRASTIC, are used to infer the potential for contaminants to enter ground water. These settings form the basis for the entire system and create units which can be graphically displayed on a map.

The relative ranking scheme uses a combination of weights and ratings to produce a numerical value, called the DRASTIC INDEX, which helps prioritize area with respect to ground water contamination vulnerability. The entire system optimizes the use of existing data and provides an evaluation which can be used to direct resources and waste disposal activities to appropriate areas.

These rankings are applied to represent areas larger than 100 acres, thereby making the DRASTIC system an excellent planning and screening tool to assist land use decision makers. Hence, what was once an intangible thought process in the minds of experienced hydrogeologists is now a graspable system with outputs which are both visual and verifiable. The DRASTIC system is a fundamental mind-set on how to approach potential ground water pollution problems with logic and confidence.

In conclusion, we of the National Water Well Association, are convinced that the problems of ground-water pollution are (1) somewhat less catastrophic than many believe, (2) better understood than some are willing to admit, (3) manageable with a few exceptions, and (4) have a special ally that with time allows this temporal concern to be overcome--that ally being Mother Nature.

While evidence of ground water pollution can be found in nearly every county in America, the volume of water contaminated is amazingly small. Happily, pollutants in ground water show little evidence of the dispersion that affects surface water from bank to bank and top to bottom in a water course. The volume of pollutants entering the ground water is small when measured against the total volume in all our underground reservoirs; it does not spread out significantly through its entire period of underground transit which may be decades, centuries or longer.

We believe that we have yet to pollute 1 percent of our total ground water supply. We can eliminate the initiation of new sources within 10 years and create a public ethic and morality which will put an end to all such ill conceived practices. The existing plumes will not have moved much further or polluted much more. The odds are in our favor to end up with 98 percent of our ground still unpolluted at the end of this century. We will still be left with decades of work to contain, control and remove the mess we've been making throughout most of our lifetimes, but it will be seen clearly as a manageable job no longer worth screaming about on TV or tabloid. We have not been sitting on our hands, and the number of professionals with the competence to deal with these ground water quality problems is multiplying in a healthy manner. More enthusiasm can be generated toward tackling the tremendous tasks facing us by recognizing the good things we have going for us and the strong possibility that we are equal to the challenge ahead--rather than by joining the ranks of the legion of doomsayers who revel in the pessimism of ignorance.

GROUND WATER CONTAMINATION AND PROTECTION

THURSDAY, NOVEMBER 14, 1985

U.S. Senate,
Committee on Environment and Public Works,
Subcommittee on Toxic Substances
and Environmental Oversight,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:07 p.m., in room SD-406, Dirksen Senate Office Building, Hon. David F. Durenberger (chairman of the subcommittee) presiding.

Present: Senators Durenberger, Humphrey, Baucus, Moynihan, and Mitchell.

OPENING STATEMENT OF HON. DURENBERGER, U.S. SENATOR FROM THE STATE OF MINNESOTA

Senator **Durenberger**. The hearing will come to order.

I want to begin this afternoon by acknowledging the ground water protection legislation that has been introduced by my colleagues, Senator Mitchell, who is here, and Senator Baucus, who is the ranking member of the subcommittee. I welcome this legislation as another contribution to our efforts to collect a broad spectrum of views during this year of oversight hearings.

I congratulate the authors on the specific provisions that they have included in the bill.

As has been widely reported, I also intend to introduce a ground water protection bill at some point, but in this session of the Congress, my highest priority has been reauthorization of the Safe Drinking Water Act, and I continue to believe that we can send the President a bill before the end of this session.

If that is the case, however the conferees decide to handle the standard setting issue, we will be giving EPA a big job to do and a short time to accomplish it. If they are to meet the deadlines contemplated for standards in the House and the Senate bills, they will need more resources than have been dedicated to the Drinking Water Program in the past.

The administration is now in the process of developing the 1987 budget, and if Congress adopts some version of Gramm-Rudman, we will also be on a much shorter fuze for 1987. So we need to wrap up the amendments to the Safe Drinking Water Act right now.

I have said many times that we should not attempt to add a comprehensive ground water protection program to the Drinking

Water amendments. I have said it because members of this committee from both parties have asked me to say it. The Senate is not yet ready to consider a comprehensive ground water program, and especially not as an amendment to a conference report on drinking water.

Even if we could get a comprehensive ground water program through the Senate, I am sure that it would invite a Presidential veto of the Drinking Water amendment. There is enough on there now to invite a veto.

So despite my personal interest in moving this country toward a national policy that protects ground water resources, I have withheld legislation of my own. I don't want the House to think that if it holds out a little longer in the Drinking Water Conference, the Senate is ready to do a big ground water bill.

That consideration aside, we have also delayed drafting a bill because there have been many organizations across the spectrum of political views that have been working to develop their own ground water protection recommendations for us and for the people of this country. Many of those groups expressed the hope that their thoughts and views would be incorporated in the legislation that we put together.

In the middle of last summer, it was clear that three major groups—the National Water Alliance, the National Environmental Development Association, and the National Groundwater Policy Forum—would have their projects done this fall. We have given these groups an opportunity to join the debate that shapes legislation by awaiting their recommendations.

As most people know, two of these groups testified at our October 24 hearing. The third group, the National Groundwater Policy Forum, chaired by Governor Bruce Babbitt of Arizona, is with us today. Reading the report of this organization late last evening, I think they are making a very great contribution to the debate, and I am pleased that we have withheld acting so that their views can be included.

We plan one or two more oversight hearings yet this fall, and if we can get the Drinking Water Conference wrapped up quickly, we may get a consensus bill introduced sometime this session.

I hope that all members of the committee will lend a hand in drafting legislation, and by this time next year, we can join together in saying that the Senate is ready to send the President a ground water protection program.

With that, let me yield to the ranking member of the subcommittee, or to Senator Mitchell who preceded him here today.

OPENING STATEMENT OF HON. MAX BAUCUS, U.S. SENATOR FROM THE STATE OF MONTANA

Senator BAUCUS. Thank you, Mr. Chairman.

I think this is probably one of the most important hearings we are going to have on the subject of ground water, partly because of the report that was issued and discussed this morning, and also because we are beginning to build up a head of steam on this issue and it is beginning to reach a critical mass, a point where some of the questions that affect ground water are beginning to come together.

It is my hope that the panel today will address the report that they issued recently, the work with the Governors Association, the Conservation Foundation, to help us to formulate a policy here. In addition to that, help us with the expedition of the Safe Drinking Water Act.

I think also the bill I introduced, which is a point of departure, will show to the House that we are serious about a far-reaching ground water approach, and that will help, I think, expedite the Safe Drinking Water Act.

I have a lot of questions that I am going to ask later on, that is my opening statement.

Senator **Durenberger**. George.

OPENING STATEMENT OF HON. GEORGE J. MITCHELL, U.S. SENATOR FROM THE STATE OF MAINE

Senator **Mitchell**. Thank you, Mr. Chairman.

I am pleased to join you and Senator Baucus on this the fifth in a series of hearings on ground water protection. I want to commend you, Mr. Chairman, for your leadership in focusing national attention on ground water pollution. No one in the Congress or the country has done more to help define the seriousness and national scope of this problem.

I thank you for your willingness to hold these hearings, and letting me join in them. I look forward to working closely with you as we consider various approaches to protect ground water. It is a serious national problem. It is a serious problem in my State. Thirty percent of the people of Maine rely on ground water from private wells for their drinking water. Reports of ground water contamination from sources such as leaking underground storage tanks, and waste disposal sites are coming from every part of my state.

A new understanding of the value of ground water has prompted strong public concern in Maine and in other States for improved efforts by Government to protect this valuable resource.

Mr. Chairman, I am confident that we all share a concern for this problem and a determination to find an appropriate approach to address it. In the hope to foster discussion, I recently introduced, with Senator Baucus and others, a bill designed to expand protection of ground water. That legislation would provide for comprehensive and coordinated protection of the resource. It will provide States with a major role in ground water protection, while the Federal Government will provide technical assistance, grant support, and oversight. It would provide a process for setting standards for ground water contaminants, and it focuses on several specific ground water pollution sources which are of national concern.

I want to emphasize here what I said when I introduced the bill. It is intended to offer one approach to addressing the problem of ground water pollution. It is not the only approach. It does not answer all the questions that can be asked. There are clearly several alternative approaches that can be and should be considered.

I believe, however, that if we are to get the best product in the long run, we need to consider in open public debate all of the various ideas and approaches. I recognize, Mr. Chairman, that your views on the best way to protect ground water may differ somewhat from the approach outlined in the bill that has been introduced. I look forward to working with you, Senator Baucus, and other members of the committee to develop the best possible legislation under your leadership to protect this vital resource.

I want to join in welcoming representatives of the Conservation Foundation Groundwater Forum to this hearing. The Forum represemtats a wide spectrum of public groups and private organizations. Members of the Forum have grapped with many of the ground water protection issues, which this committee is seeking to resolve. I look forward to today's testimony and to studying your report in detail.

Thank you.

Senator DURENBERGER. Thank you very much.

Gordon, do you have an opening statement?

Senator HUMPHREY. I have no statement.

Senator DURENBERGER. Thank you very much for being here.

Our panel of witnesses this afternoon are representing the National Groundwater Policy Forum, a group of 17 distinguished Americans who were brought together by the Conservation Foundation and the National Governors Association to find a consensus on what the Nation ought to do about its ground water problem.

Chairing the group is Gov. Bruce Babbitt of Arizona, a Western Governor who may tell us that it was Jim Watt who brought him into the national debate on ground water protection. With Governor Babbitt today are: Phil Masciantonio, who is the environmental affairs vice president of United States Steel; Frank Loy, chairman of the board, Environmental Defense Fund; Bill Reilly, the president of The Conservation Foundation; Ted Schad, who was executive director of the Groundwater Forum; and Toby Clark, who is the vice president of The Conservation Foundation.

Gentlemen, we welcome you all to the hearing. I understand Bill Reilly is going to start the proceedings with an introduction of the Forum and the Governor.

STATEMENT OF WILLIAM K. REILLY, PRESIDENT, THE CONSERVATION FOUNDATION

Mr. REILLY. Thank you very much, Mr. Chairman.

On behalf of The Conservation Foundation and the National Groundwater Policy Forum, I would like to say how much we appreciate this committee's interest and involvement in this issue, the very strong leadership position of the chairman and members of the committee, and your very quick and forthcoming response to the release of the report on which the ink is scarcely dry.

It is the product, as several of you have mentioned, of a very unusual group of people who have spent the better part of the last year grappling with what we see as one of the major, perhaps the major, national environmental problems that is significantly unaddressed as a matter of national policy.

We see this as another milestone in the movement in water policy from the era of water development to water management. The fact, I think, that we have got the chief executive officers of

Standard Oil of Ohio, the United States Steel Corp., Monsanto, joining with the chairman of the Environmental Defense Fund, the chief executive officer of the National Wildlife Federation, three very distinguished Governors, and a group of State and local representatives, as well as several experts on ground water from science, public policy, and law, I think is a very significant testimony to both the sense of national urgency people feel on this issue, and the readiness of important sectors of this society to begin to deal with it.

We have had the great good fortune to have as the chairman of the National Groundwater Policy Forum the Governor who suggested it in the first place, just about 2 years ago, who had the idea for it, who with us put together some of the early concepts for what it should do and helped us get the group that is represented here today.

He, himself, has a very distinguished record in Arizona on water. He was, at the time that he had the idea for this forum, the chairman of the National Governors Association Water Subcommittee, and we have been pleased to have him in this role. I am pleased to introduce him now, Governor Babbitt.

STATEMENT OF HON. BRUCE BABBITT, GOVERNOR, STATE OF ARIZONA

Governor BABBITT. Thank you, Bill.

Mr. Chairman, and committee members: I would simply echo Bill's thanks to all of you for affording us this opportunity to join you. I acknowledge, Mr. Chairman, your help and counsel during the entire course of this year-long study. You have been most helpful and we appreciate it.

I acknowledge today that Secretary Watt was the causative force that brought this Groundwater Forum before you today. In 1982, the Secretary wrote me a letter that said:

> Dear Bruce, the Federal Government is beginning to assert some interest in a Federal role in the regulation of the ground water. That violates my concept of State sovereignty, and I am sure it violates yours, and I call upon you to join with me in opposition.

That letter triggered some very intense discussion among the western Governors, public officials, environmentalists, water engineers, and I would say really awoke us to the reality of this environmental issue. We began to see that it has really been out of sight and out of mind. We have been nibbling at it around the edges, but somehow there hadn't been any systematic attention.

Nobody has ever stood on the edge of a body of ground water and watched a beautiful sunset. You don't fish in ground water. You don't swim in it. You don't row a boat on it. Somehow it has been the last of the major environmental issues to come into focus. That, of course, brings us to the process that Bill Reilly described, and to the report which we submit for your consideration today.

I would say that the major innovation contained within the pages of this report is its concept of a State/Federal role. Our deliberations reached the conclusion that regulation of ground water is sufficiently different from clean air and clean water issues, sufficiently complex, sufficiently diverse, vested with a history of State regulation in States like Wisconsin, Florida, and Connecticut, some part of New York, that we really ought to deliberately attempt to build a model that attains a real partnership, not the preemptive model of clean air and clean water in which the Federal Government runs the program, sets the standards, administers it, and calls upon States to be subcontractors to carry out the federally defined responsibilities.

It is our judgment that in this case, the regulatory process would be stronger, would yield a better result, with a Federal role which consists of setting a goal, defining what it is we are after, then mandating the States to put together programs with a certain specified number of components.

We are all familiar, I think, with what those components and outline have to be—data acquisition, definition of and mapping of aquifers, proper classification of those aquifers, setting proper use of ambient ground water standards, strong source controls, programs for following up, monitoring, and enforcement.

It is our judgment that within the pages of this report, if the Federal Government can make certain that States act, then give them leeway to deal with the problem creatively, on their own, the way that Florida and Wisconsin and Connecticut and other States have done. Ultimately the diversity, imagination and pluralism and power of States and public groups responding to unique circumstances will yield a higher quality, a better product under that model of State/Federal regulation. But it will take some push from the Federal level. In that respect, we do advocate that the Federal Government define a national goal, mandate States to put together minimally acceptable programs, and have at hand sanctions for those States that chose not to do it, namely the withholding of Superfund moneys directed at the cleanup of ground water, on the theory that it makes no sense at all to spend Federal money cleaning up ground water in States where the process that created the problem has gone untended.

That, in sum, is our suggestion. It is a consensus recommendation. I must say that it is a comforting, if strange, feeling to be sitting between my two vice-chairmen, the president of United States Steel Corp. and the director of the National Wildlife Federation, saying: We are here in concert. We believe the time is ripe. Public opinion is focused. We need your assistance in getting this done.

Thank you, Mr. Chairman.

Senator DURENBERGER. Thank you, Governor.

Does anyone else have an opening statement?

Mr. REILLY. A brief opening statement by Frank Loy, and by Phil Masciantonio.

Senator DURENBERGER. Frank, thank you very much for being here.

STATEMENT OF FRANK E. LOY, CHAIRMAN OF THE BOARD, ENVIRONMENTAL DEFENSE FUND

Mr. LOY. Mr. Chairman, I have given the committee a written statement, which I will not read.

Senator DURENBERGER. All of the statements will be made part of the record.

Mr. Loy. I would like to comment on three things from that statement.

I am pleased to have a chance to testify on the problem and on the proposed solution that is contained in the report. I want to pay tribute to Governor Babbitt's chairmanship because the fact that the diverse elements in our group in fact came up with a consensus report is, I would suggest, maybe a little surprising, but it is no accident. First, I think we were very anxious to get a consensus report and, second, he brought us to that conclusion with a gentle guidance which was helpful.

I think we are asking this committee to do something which is very difficult; that is to legislate at a time when we, ourselves, say that that there is no crisis. We say, this Nation is not yet facing a ground water crisis. But I very much hope that while that sentence is focused upon, and I believe it to be accurate, that this committee and the Congress recognize that if you don't act now there will be a crisis, and that the cost of correcting the evil that would come with additional pollution of ground water over time would be enormous, and to some extend maybe simply not fixable.

We believe exceedingly strongly that the time is now. The reason we struggled to get a consensus report is that we believe that it ought to make it easier for the Congress to act now.

Second, I do think this document ought to get your attention, not only because I believe it has sensible suggestions in it and recommendations, but also because it does represent a consensus of verying groups, and that, it seems to me, should be helpful to the committee.

If I had written this report by myself, it would have sounded somewhat different, and I would guess that if Phil, at the other end of the table, had written it, it would have sounded somewhat different, but it wouldn't have gotten the attention that this report deserves and I hope will get because it is the product of this group.

Third, I think Governor Babbitt referred to a central issue that we faced and that we have resolved in a way that I believe is satisfactory. That is the central issue of what is the role of the Federal Government vis-a-vis the role of the State and local governments, and, to a slightly less critical extent in our discussions, the role of private industry.

The role of the Federal Government, as we envision it, is relatively limited compared to those of other environmental statutes. I am sure that there will be some from the environmental community who will say that it may not be strong enough.

I believe that if the legislation incorporates the proposals herein, it will be strong enough. But I do believe that we ought not to fool ourselves into thinking that because we describe it as a local problem, different in every area of the country, different in every State, that in fact it needs only State and local attention. Without a rather muscular Federal role, as described in the report, this is not going to work. The role that is set forth here has a number of components.

First, it proposes to establish in Federal law a goal, and it states that goal quite carefully as being to protect the physical, chemical, and biological integrity of the Nation's ground water resources, and to ensure that they are not degraded in any way that may be harmful to humans or to the environment.

Then it goes on, in the second component, to talk about the requiring of adequate State ground water programs, and it indicates at least six elements that would have to be in those programs for them to be considered adequate.

It goes on to then suggest, third, that EPA have authority to determine the adequacy of those program, and we believe that that is not as intrusive a role as might otherwise be because the law, as it is assumed here, does actually say what ought to be in the State plan. That, obviously, makes it easier for the EPA to determine whether the law is being met or not.

The fourth component of the Federal role is a set of strong inducements, including citizen suits against recalcitrant governments and the withholding of key Federal grants and programs if there are no adequate State plans.

We think most States will address these problems because they see the problem very much the way that you, Mr. Chairman, Senator Baucus, and Senator Mitchell have described it, but there will be some that will be slower and some who will need some prodding.

The fifth component, and let's not ignore it or think that we can do without it, is a Federal financial and technical assistance program of some magnitude which will make it possible for the States to put together the plans that are necessary to protect the ground water resources.

The last component which we provide is a periodic oversight of the State programs. EPA and the Geological Survey will provide some oversight in their normal operations. But the other type of oversight that we recommend is review by a commission composed of a mix of interests similar to those that were actually represented in the forum, which EPA and the States will establish, we suggest, every 5 years.

In the long run, such public reviews may be one of the more important innovations recommended by the forum, that will prevent this needed legislation either from becoming a dead letter or from going into some direction unanticipated. We believe that it is a useful concept, and we are looking forward to participating in these periodic reviews.

Thank you, Mr. Chairman.

Senator DURENBERGER. Thank you very much, Frank.

Phil.

STATEMENT OF PHILIP X. MASCIANTONIO, VICE PRESIDENT ENVIRONMENT AFFAIRS, UNITED STATES STEEL CORP.

Mr. MASCIANTONIO. Thank you, Mr. Chairman.

I am representing Mr. Roderick, who unfortunately could not be here today due to a previous commitment. But I do want to assure you of his interest and dedication to this project. He actively took part in the meetings and the development of the document. I must say that we are proud to be associated with it. We think that it is a good example of how industry can work together with local and State government officials, and environmental organizations to develop a consensus-type approach.

We feel that the ground water issue is not only important for the Nation, but certainly, very, very important to industry. It is one of the keys to insurance of future economic development and improved productivity for industry in this country. Therefore, we felt that the role of industry in this thing would be significant.

We had Monsanto Corp., represented by Mr. Hernandez, and we also had John Miller of SOHIO, who participated actively along with their staff. We are greatly indebted to Governor Babbitt for leading this group through some very difficult sessions, and to arrive at a consensus position.

I think that one of the unique things about this document is that it presents, perhaps, a precedent setting approach to environmental regulation. It is asking for a Federal law, at the same time it is saying that that Federal law has got to be such, because of the unique nature of the ground water problem, that the States have the primary responsibility in developing the plan, implementing it, and enforcing it. We think that that is important.

I think that it is important not only from the standpoint that there is a need out there, and the States are the ones that have the knowledge and who have the interest to express that need, and to carry out and implement what is necessary to satisfy the local and statewide problems.

The other thing the group focused on was that perhaps the unique partnership needs to see more than normal in the way of voluntary actions. I think that a burden falls upon industry, particularly in that respect. Not that industry is singled out as the prime polluter of our ground water, certainly there are other problems. I think that the group's consensus was that we don't have a crisis, that most of our ground water is in good shape, but we need to work diligently to protect it. The role that industry would seem to play would be to utilize its expertise in developing processes that are pollution-free, to reexamine the systems that we now have in place, to modify those systems to make them less polluting, and to examine recycle and reuse techniques so that they can eliminate present pollution problems.

I think that industry is prepared to work toward that goal. As a matter of fact, many companies, as you all know, have already put into place in a voluntary manner programs to reduce significantly the amount of waste that they have to dispose of.

I think that this all has been a very good exercise. We are, as I said, proud to be associated with this. It is not a perfect document, but I think it does point a direction that we hope to have the Congress examine carefully and to consider in their future deliberations toward legislation.

I think that concludes my statement, Mr. Chairman.

Senator **Durenberger**. Thank you very much.

I know that Dave would be here if he could. He is probably the one person who has one of his feet in each of these organizations, which obviously demonstrates the concern that he has personally for the ground water.

Let me begin with a question.

Mr. **Reilly**. Mr. Chairman, let me make one additional comment before we do begin that I should have made before.

The Congress, I know, has periodic occasion to inquire into the uses of philanthropy, and I would be remiss if I did not mention the philanthropic organizations that made all of this possible, and who expended money on the public policy process, which proportionally not a lot of philanthrophic money goes to in this country. Those funding sources include: The Donner Foundation, the Joyce Foundation, the Ford Foundation, Exxon Co., USA, and the H.J. Heintz Co. Foundation. We are grateful to all of them for having supporting our water program, this environmental dispute resolution exercise from the start, and the forum in particular.

Senator DURENBERGER. On behalf of 501(c) (3), (4), and (5) and three members of the Senate Finance Committee, we are grateful to you for making that reference.

Let me begin with Governor Babbitt, in an effort to find out, if I can, just exactly what is new and novel about this Federal/State partnership that several of the witnesses have talked about.

As I understand the report, it specifically says that the Federal Government should pass legislation requiring States to enact legislation. I don't know that we have currently a Federal law just like that, so I guess that is unique. We have laws that deny States money unless they comply with mandates. We have laws that threaten States with EPA programs if they don't have one of their own. We have laws that regulate States when they are acting as proprietors as opposed to when they are acting as sovereigns. But we don't often directly require them to adopt and enforce a specific regulatory program.

On page 24 of the report, there is an advocacy of denying a whole series of grants—EPA grants, Corps of Engineers grants, USDA funds, et cetera—to States that don't develop ground water programs.

I have to recall for the Governor that when we were on Advisory Commission on Intergovernmental Relations together, we used to try to sit next to each other to share our great views on the future of federalism. Some years ago, the Wall Street Journal ran an editorial—this is in 1982 or 1983, when we were talking about the 21-year old drinking age here the Journal ran a great editorial written by the then Governor of Arizona, and it was a strong complaint about Congress and the mandates, and not trusting the States with some decisions.

Having read this report, probably a little late at night, being foggy on my recollection, I wonder if the current Governor of Arizona could tell us whether or not he, it, or what has gone through some kind of revolution since we sat together on ACIR.

Governor BABBITT. Mr. Chairman, if I may translate, the question is: What is a States-righter like Bruce Babbitt doing here advocating a Federal law?

Senator DURENBERGER. That is getting to the point, Governor, particularly since you took on the cloak of Jim Watt at the beginning of this hearing.

Governor BABBITT. Mr. Chairman, I think that is a fair and important threshold question that ought to be asked every time the Congress steps up to a law or a regulation. My answer would be as follows: I believe that in areas of environmental protection, there are two strains of concern that require a Federal presence, indeed justify it very richly in terms of the results of clean air and clean water. Those two strains are: No. one, public health which I believe that even some of the more unrepentant colleagues of mine would concede to be a Federal responsibility, or at least a matter of Federal interest; the second is the fugitive industry, beggar-thy-neighbor argument. At least in frame work, some measure of environmental uniformity is necessary to prevent States from simply abdicating regulation as an inducement. This is what economists call "externalities."

Against that background, I am here to say this is surely a fit matter for Federal regulation. That is really what the Watt letter triggered. The question then becomes: How far do you go? Where do you find the nice balance?

You asked me: Should the Federal Government order the States to pass laws? I recognize that that is an art form, and that the Congress never orders the States to do anything. What Congress does is say: Here is Federal money. It is unavailable unless you voluntarily and freely choose to do the following. Some would call it a bribe. Some would call it an inducement. But that is the art form that we engage in, and ultimately a Federal mandate is going to be enforced by Federal marshals or by the States doing something in their own self interest with adequate incentives. That is what this does.

I think that the important thing, as we philosophize here, as alumni of the ACIR program, is not the threshold question of Federal involvement, but how much Federal involvement. How do you do it in the most productive way, a way in which the Federal participation does not become a mandatory minimum which, in turn, becomes a maximum under which States do just that much and nothing more.

If we can answer that in a dialog between the States and before this Congress, I believe that we may be setting a precedent that will bear some very nice fruit for everyone.

Senator **DURENBERGER**. Let me ask the rest of the members of the panel, as well stepping the role up a notch.

In the hearings we have been having on ground water, maybe I am oversimplifying that, but it seems to me that the debate on this subject has been on the subject of goals. Where we are headed has come down on two different kinds of goals. One, I will call a differential protection goal. There the notion is that you don't have to protect all of the ground water resource, that you ought to protect aquifers according to their current or their expected use. If it is not likely that a particular aquifer is going to be used for drinking water, then you don't need a high level of protection.

The other goal that has been proposed is commonly referred to as nondegradation. The nondegradation goal says, in effect, the purpose of Federal legislation is to prevent contamination, not to decide which aquifers are not needed.

On page 3 of your report, you state your goal, and then you go on to say and I quote: "The importance of ground water is such that the national quality of life requires that the country aspire to the highest and best end of preventing its contamination."

Then, on the other hand, your report goes on to recommend that States develop classification schemes, which sounds to me like differential protection.

So my question is: If you recognize this debate between nondegradation and differential protection, does the forum come down on one side of that debate or the other?

Governor **Babbitt**. Mr. Chairman, it is an extraordinarily difficult and complex question that you are leading me into and inviting me to blunder through.

I think we start by recognizing that what literal nondegradation—we have some nondegradation standards in Arizona—means is no development, no human activity of any kind, period. We are doing some land-use classification in some recharge areas which says we mean the full implication of nondegradation; there will be no human activity of any kind. Maybe a couple of bird-watchers, but that is it.

Recognizing that reality, we have said maximum protection and we have said classification and ambient standards must be used to accomplish that goal. In some areas, you will have literally nondegradation, with no use at all. In other areas, drinking water may, in fact, be the appropriate ambient standard to manage to.

The complexity of that issue inevitably, I believe, requires that you say to the States: Here is the goal, and we want you to go out in an anticipatory fashion, and classify your aquifers in a way to get as close to that goal as is humanly possible. You have to locate hazardous waste somewhere. Does it pose some risk? Hopefully you design by 100 or 1,000 year standard so that there is minimal risk.

You have to deal with those ambiguities, and the only way to do it that I know of is to make decisions about land use, and to make them against ambient standards. It is our recommendation that that issue be left to the States. The States that have dealt with it have done so in a very, very impressive fashion. We believe that we ought to play on that strength because it is going very well, and we ought to simply push that process along.

Senator **Durenberger**. Any other comment from anybody?

Senator Baucus.

Senator **Baucus**. Thank you, Mr. Chairman.

I think, gentlemen, the approach that you address here is a good one, I think that it is one that most everyone agrees with. What concerns me is that there are a lot of nice sounding words, but I am not sure that it is going to advance the resolution very much. Words like "partnership," everyone agrees with partnership, but what does it really mean?

What specifically are you recommending to help advance this further, the goal being the protection of our ground water, obviously? To some degree, I think some people may look at this report and say: That is all well and good. It is apple pie and it is the Fourth of July, and it is motherhood, partnership, State responsibilities.

What can you tell potential cynics that might be thinking along the lines that I just stated? What is in here that is specific, that leads us to believe that, in fact, we are going to protect our Nation's ground water, and not just a lot of nice sounding words?

Governor **Babbitt**. The cynics, among whom, Senator, you are manifestly not one.

There has been a profound change in this country since the environmental laws were adopted beginning in the 1960's. There is in every corner of this land a strong, strong sense of public concern about these issues.

Page 10 of this document says that with sanctions and inducements, the Federal Government will say to each State: You must adopt a program of six mandatory parts to meet review by EPA. It transfers the action to the States.

The cynics say as follows: The chemical companies, the oil companies, and all of the forces of darkness will convene upon the State legislature in the middle of the night and pass out a law.

That might have happened in 1960, but it will not happen in 1985.

Senator **Baucus**. Why will it not happen now, although it may have happened a few years ago?

Governor **Babbitt**. Because in every State of the Union there are now big environmental and public interest groups who have the power to block the passage of a token law. That is the bottom line.

Senator **Baucus**. I am a little concerned because one recommendation here is that the Federal Government, through EPA, give States financial assistance to develop the inventory and determine the nature of the aquifers, and so forth. With Gramm-Rudman heading down the track full speed ahead, I don't know how much Federal assistance is going to be going to States in actuality.

Governor **Babbitt**. That is the beauty of this law.

Senator **Baucus**. I am talking about the financial assistance.

Governor **Babbitt**. I hate to admit this, coming to advocate Federal grant programs, but Federal money is not a major inducer in this program. Look at States like Connecticut and Wisconsin.

Senator **Baucus**. I appreciate that, but what if an aquifer flows right on the border of a State into the neighboring State, what are you going to do about that?

Governor **Babbitt**. The "beggar-thy-neighbor issue" is already under control because the United States Steel Co., and most industries are under the discharge permitting requirements of the existing environmental laws, including specifically the manifest provisions of RCRA. This is really management stuff. The gaps now relate to agricultural practices, to mining wastes, to small discharges. The big industrial kind, the idea of a mobile steel company on wheels searching for a nice State, that has already been taken care of.

Senator **Baucus**. Perhaps you can clear up a misconception I may have. It is my understanding that if the States adopt these standards, they supersede their Superfund determinations. So far we don't know how clean clean is at the Federal level. My understanding is that the approach that the Commission recommends is that if the States set standards, such as recommended by the Commission, the State standards will supersede what the Superfund standards might be.

Governor **Babbitt**. Senator, this is not aimed at the clean up situation. This is really aimed at managing prospectively.

Senator BAUCUS. What about the ground water standards, do they affect?

Governor BABBITT. I understand. The interplay in specific clean up between State ground water standards and RCRA would inevitably be involved in favor of what the Federal Government wants under RCRA, under Federal supremacy. That is a very small piece of the problem. We are looking at the other 99 percent.

Senator BAUCUS. Thank you very much, and I hope it works.

Governor BABBITT. With your help, Senator, it will.

Senator BAUCUS. I pledge my help, but you are the experts here, you are the commission, and we need your help, too.

Thank you, Mr. Chairman.

Senator DURENBERGER. On the issue of source control, in the course of previous ground water hearings, we heard from State officials who asked us to consider technical assistance from the Federal Government in the way of guidelines for controlling unregulated sources of ground water contamination.

In your recommendations, you state, "Localities must ensure that both regulated and other potential sources of contamination are controlled as well as implement other parts of their State's management program. Congress should instruct EPA to evaluate the need for and the techniques of controlling unregulated sources."

My question is: What comes first? Would you expect EPA to provide specific control guidelines in a timely manner to localities in order to assist them in implementing State programs?

Governor BABBITT. Senator, I don't think so. I believe that this Congress can safely say to States "get on with source control" recognizing that the big source control issues are probably non-point sources on which there has been precious little wisdom developed so far, either in the Nation's capital or in most of the States.

I think that it would be a mistake to expect guidance from on high in lieu of simply getting on with it. The one area where I believe we all have a common interest in more intensity of Federal effort is this business of risk assessment because ultimately drinking water standards and ambient standards, which would be set by States, must relate back to good risk assessment, and that is unequivocally a Federal responsibility far beyond the capacities of even a sophisticated, strong, and well-led State like Arizona.

Senator DURENBERGER. Let me ask a related question, and then I may have to recess this to go over and vote. The report departs from the recommendations of other groups, and many of the existing environmental programs by emphasizing local government, and the fact that local government needs to play a role here.

Let me ask you if you can be more precise about how local government can play that role. Isn't local government a little bit too local? In the Minneapolis-St. Paul Area, we have something like 195 units of local government. We happen to also have an areawide or a metropolitan council, a strong planning agency working for local government. There are also only two aquifers in that whole area. But it strikes me that regional planning and all that sort of thing has been sort of out of favor for a while. How does the report propose that local government play a role in this whole process, and are there some variances city-by-city that the report has in mind when it tells us that we ought to rely more on local government to help us through this process?

Governor BABBITT. Mr. Chairman, I think we all understand that the regulatory model must, at its core, be a Federal/State model, and the States ultimately must be accountable for everything that goes on within their borders.

The reason for that language, at least from my perspective, is Long Island and a guy named Peter Cohalan, the Suffolk County Executive who participated in this project and gave us a wonderful insight into what is happening in Suffolk County, Long Island, NY, the home of Senator Moynihan, who now joins us.

Senator MOYNIHAN. The chairman has gone to vote, and he will be right back, and I will preside for the moment very happily.

Governor BABBITT. Mr. Chairman, if I might, we had just reached Suffolk County as you walked through the door.

Senator MOYNIHAN. I heard you.

Governor BABBITT. The question is the relative roles to be played by State and local governments in this issue of the management of ground water.

I believe this group feels that there is very much an opportunity for an enhanced State role in this Federal/State partnership, but we must be sensitive to some really outstanding examples of management at the local level.

The interesting thing about Long Island is that it is a sole source aquifer. A huge population sitting on a very fragile ground water table, threatened by salt water intrusion, threatened by pesticides used in agriculture, and which is being managed in the most intensive manner by local officials—zoning, land-use classification, the prohibition of development on recharge areas. That is, of course, precisely the thing that a Federal law ought to enhance and encourage.

Senator MOYNIHAN. I might just make a point on this general subject. The water that you drink today on Long Island fell as rain 50 years ago, that is about the cycle. Fifty years ago, half the chemicals in use in the country were not widely used. There are parts of that aquifer that are not usable any more. The great virtue of the Long Island situation, which is not the case across the country, but it is the case in many parts of the country, is that all you have to do to keep a permanent supply of pure water in Long Island is to do nothing more. If you do that, you will be fine. If you don't do that, you are going to have to abandon the site in about 50 years. It is curiously a 50-year decision, and unfortunately, we don't have 50-year terms in the county legislature.

Your report recommends that if a State fails to adopt a comprehensive ground water management program that Federal funds be withheld for ground water activities. Would you want to be specific as to the kinds of Federal funds, that could run all the way from very specific Corps of Engineer projects to Superfund projects, which usually get into ground water issues.

Governor BABBITT. Senator, anything except the Central Arizona project.

Senator MOYNIHAN. Do you find that States are becoming conscious enough of this subject to participate? We are not sure. I have been pressing the Long Island situation because it is singular in the number of people who drink from one well. But we have not had much response. This committee is responding. Senator Durenberger is responding, but we don't hear from out there, it is not as if anybody wanted us to do anything.

Governor BABBITT. Mr. Chairman, I would like to ask Mr. Loy, an environmentalist, to answer that question.

Senator MOYNIHAN. What is the problem? People are always asking us to do something around here, but this is curiously muted. This may be a personal impression, but I have been at this legislation for 8 years.

Mr. LOY. The first reason was stated earlier by Governor Babbitt very eloquently. You can't fish in this resource, and you can't see it, and you can't boat on it, and you can't swim in it, it is not visible. Therefore, it is much more difficult to arouse groups to the threat that pollution holds for it.

We share in large measure Governor Babbitt's belief. Let me state it a different way. We were worried, in the environmental segment of this forum, that we were opening the door to States adopting plans that, in fact, had no teeth, plans that were token efforts sufficient to get Federal approval, but not sufficient to deal with the problem.

That risk exists because—let us face it—there are no Federal standards that are set forth herein to which the States must come. The test of adequacy is quite imprecise and deliberately so.

On the other hand, I believe personally, and I believe that many environmentalist organizations would agree with this, that in the State legislatures, the ability to shove this problem aside is a lot less than it was before because, quite frankly, of organizations like ours, and others that are bigger and wealthier, who do pay attention, and who do point out in various legislatures the risks involved in token response to these problems. Therefore, the likelihood is that States will be more responsive than would have been true some time ago when these organizations were not as effective.

On balance, we think that you are going to get meaningful State action in most cases, and that when you don't, the provisions here for sanctions are adequate.

Senator MOYNIHAN. Could I ask you just one last question, and then let Senator Mitchell have his turn.

In terms of the sanctions, when we leave out the central Arizona project, would you extend it to Superfund eligibility?

Mr. LOY. To the extent that Superfund problems result in degradation of the ground water, yes. To the extent that Superfund funds are needed to clean up threats to the ground water, I believe this calls for that.

Senator MOYNIHAN. It does make sense. We are having problems with that Superfund, as you may know. We are not sure what it does. We know what it is supposed to do, but we are not sure what it is doing. I will leave that as a dangling participle.

Senator Mitchell.

Senator MITCHELL. Thank you, Senator Moynihan.

I commend all of you for your effort in this. I have not had an opportunity yet to read your report in detail. I have skimmed through it, and my staff has made a brief summary, but I do look forward to the opportunity to read it in detail. I do have a few questions.

As you know, the central issue in terms of programs is whether it should be a national program, or whether the program should be left to the States. There is a good deal of comment that it ought to be national because States—at least many of them—will not accept the challenge and will not develop meaningful ground water programs.

Some have expressed concern that any State adopted standards would be, in some areas, not meaningful protection. One suggestion to address this is to provide that the Federal Government have authority to overrule State standards. We do this now for surface water. Another approach is to set a floor and indicate that State standards can be set at any level at or above the floor.

I would like to ask you all, beginning with you, Governor, are you concerned that some States would set unrealistically low standards, therefore, not address the problem in a meaningful way? Second, do you have a preference for either of the two alternatives in terms of what the Federal role should be that I have just mentioned?

Governor BABBITT. Senator, there is undeniably a risk if you set the States relatively free to adopt programs subject to this rather general sign-off that we propose. I would suggest to you that it is a risk worth taking for two reasons.

The first one is the evidence that we already have out there: The number of States which have come up with remarkably comprehensive, complex, innovative management techniques that in their detail and their power go way beyond anything that EPA has even come close to.

The second problem is that a floor becomes a ceiling. That is a fact of life. I would say to you, this is a time to take a risk, and a time to really let it fly and watch. The same problem with overruling power: The States become, rather than principals, agents. I have seen it in my own bureaucracies. You can't get them off the phone to Washington. They don't know where the Governor's office is. They say: We are on the next plane to Washington to hear what the standard is by which we might be overruled.

I think this is one area where the level of public concern and the power of the environmental groups in State capitals ought to encourage you to take that risk in aid of the diversity and power that may bloom far beyond any kind of floor, ceiling, or prescriptive power in Washington. Ultimately there is a risk, and I would suggest that you take it.

Senator MITCHELL. Would anyone else care to comment?

Mr. MASCIANTONIO. I would like to add a comment to what Governor Babbitt said on that.

During the discussions with the group that made up the forum, we did have some experts in the scientific area and in water management, and I detected through those discussions that the feeling was that States are best suited to really establish classifications and set the standards.

There could always be differences of opinion as to whether the States have set the standards stringently enough to satisfy the Feds and the public. I think our suggestion that there be review and oversight on those plans gives some opportunity for review of that, and for corrective action if it is inadequate.

I think the feeling generally was that because of the local nature of these ground water problems, the Federal Government is in no more a position to set standards on ground water than they are to really set the standards for specific streams across the country. The States fundamentally have got the ability to do that now with guidance from the Federal Government.

We are saying, the Federal Government needs to develop the data, the information base, and the guidelines, and the States need then to adapt those to their own specific needs. We fundamentally feel that this is the right way to do it.

Senator MITCHELL. Would anyone else care to comment on that?

Mr. CLARK. I might add one more comment to what Phil just said.

There are certain sources that the States have to take care of. One thing about the forum's recommendation is that it is truly a resource management approach, not just a contamination protection approach. A critical element of it is controlling ground water withdrawal, as well as protection from contamination, and only the States can do that. The Federal Government cannot control withdrawals.

Senator MITCHELL. In your report, you suggest that EPA and the USGS assist States in development of groundwater monitoring programs, yet you stop short of calling for a national ground water monitoring program. Would you review for us what concerns you had that led you not to recommend a national program? What were the facts that led you to this decision, if any?

Mr. CLARK. I will take that on, again. I would say, for the forum, there are some issues that they dealt with in greater depth, and some issues that they dealt with in lesser depth. There was not a great deal of time spent discussing the monitoring program.

I think that monitoring is important, but it is also clear that as each State is going to have its own program, its own classification system, it ought to be defining what is going to be monitored and where. In some cases, you may not want to be monitoring the ground water, spending a lot of money on that, because by the time the ground water itself is contaminated, it is too late. Instead you may want to be monitoring land uses, or water and soil in the unsaturated zone.

I think that it is up to the State, in a coherent program, to decide what is most efficient to monitor in order to protect ground water from being contaminated.

Governor BABBITT. Senator, I would only add to that, as a student of this business of hydrology and geology, there is an infinity of data out there. No matter how much resource you put into this, it is going to have to be deployed in the most narrow and selective way, because to take a point source sample of the ground water beneath the city of Tucson, you need to drill a well 600 or 700 feet for one point-source sample in a dynamic body of water, the physics and chemistry of which are diverse, and which extends maybe 20 or 30 miles in one direction and 30, 40, or 50 miles in another.

The acquisition of data has really got to be right up next to the definition of what it is you are looking for. The role of the USGS, I think, must be methodology. I think that this is what we wanted to point out, their help can be to deploy technology and hydrology to guaranteeing that it is being correctly done. That once you have defined what you are after, you are going to get the correct results. That has been the historic role of the survey, and I think a very important one.

The one Federal role that I would again come back to again and again, and that is lagging very, very badly, is risk assessment. That is unequivocally a Federal responsibility. It cannot be handled by the States. EPA is defaulting on its obligation to do risk assessment for the existing drinking water standards, which are certainly a Federal responsibility.

Senator MITCHELL. Your report identifies an important role for local governments, as well as State governments. You suggest that those local governments might focus on activities to protect the especially valuable and sensitive ground water.

If you can do so now, I would appreciate it, but I would appreciate even more if you could submit to us in writing some guidance on how we might define vulnerable ground water, or are such decisions relative in nature and should they be left entirely to local decisionmaking?

I think that this is something that might lend itself to a written response. If anybody wants to make an oral comment, I will be glad to hear it.

Mr. REILLY. We will happily contact you and your staff, and work to respond to that question, Senator.

Senator MITCHELL. Thank you very much, I do appreciate that.

[The information requested follows:]

RESPONSE FROM THE STAFF OF THE NATIONAL GROUNDWATER POLICY FORUM TO SEN. MITCHELL'S QUESTION REGARDING IDENTIFICATION OF VULNERABLE AQUIFERS

Question: How can vulnerable aquifers be identified?

The National Groundwater Policy Forum developed and discussed at length some suggested criteria for states to use in classifying their groundwater aquifers and identifying those needing priority protection. While it was decided that these criteria were at a level of detail that was inconsistent with and thus inappropriate for inclusion in the Forum's "Proposed Conclusions and Recommendations," they may be helpful to the Subcommittee in dealing with the issue of aquifer characteristics.

The Forum's criteria included the following: **physical characteristics of the aquifer**, including permeability of overburden and aquifer materials, mobility of contaminants, depth to groundwater, interconnections with surface water and other aquifers, and the natural variability and quality of groundwater; **current, expected, and possible uses to be made of the groundwater**, including prospects for conjunctive use of surface and groundwater, quantity of water that maybe withdrawn, and the relative availability of adequate alternative supplies of water; **aquifer recharge and vulnerability**, including rate, sources, and characteristics of natural recharge, the sensitivity of recharge zones to development, and the location and importance of aquifer discharge to surface waters; and **land uses and activities in the recharge zone that could affect groundwater quality**, including actual and potential sources of contamination, uses that influence recharge, and existing areas of anthropogenic (i.e., human-produced) contamination.

The Forum's "Proposed Conclusions and Recommendations" did call for states, rather than the federal government, to enumerate the class or classes, to define the characteristics of any class or classes, and to perform the actual delineation of physical areas in which a classification will apply.

Senator MOYNIHAN. Could I ask Governor Babbitt and members of the panel, what precisely do you mean by "risk assessment" in terms of EPA?

Governor BABBITT. I am sure that we will each have a stab at that one.

I view risk assessment as the baseline process of determining, for example, how many parts per billion of trichloroethylene pose a given level of statistical risk of cancer, or whatever other disease may be in contention. It seems to me that there are two separate levels. The first one is purely scientific, and that is what I call risk assessment. As elusive as it is, it is a scientific inquiry—what is the statistical chance of contracting a given syndrome, such as cancer, from a specific level of exposure. It is pure science.

Then comes your realm of inquiry, Senator, academic inquiry, and that is, what is the appropriate level of risk to tolerate in this society. To that phase of the inquiry, I leave you, the philosophers, the Members of the United States Senate, and your agencies.

Senator MITCHELL. You are not suggesting that being a Member of the Senate makes us philosophers exclusively.

Senator MOYNIHAN. We do know something about risk avoidance. Risk assessment is something that we are not as good at.

Is EPA now charged with setting water standards, in effect?

Governor BABBITT. Senator, they are, I would emphasize.

Senator MOYNIHAN. In the Clean Water Act as a general proposition?

Governor BABBITT. It is the Safe Drinking Water Act.

I think that it is important to understand that everything we are talking about here today operates behind the Federal screen of the Safe Drinking Water Act, which is unequivocally a Federal responsibility, which we all concede.

The EPA, at the current time, is charged with both functions under the Safe Drinking Water Act, one, risk assessment and, secondly, setting the level of risk tolerance, if you will. It is an exceptionally difficult process, and EPA has been exceptionally bumbling in its approach to it.

Senator MOYNIHAN. Let's ask the panel. These westerners tend not to like our Government here in Washington. Have they been exceptionally bumbling, or is it an exceptionally difficult job?

Risk assessment, any of us who have worked with statistics, we have fairly standard measures, but when you get into the actual judgment of what are the causal sequences, you are into every known science. Then when you get into the question of what are the risks that such a sequence will occur, you are in the area of judgment, where very bad mistakes in public policy can be made when those issues become public.

I will accept no risks for my constituents, absolutely none. That is my view. Now, you don't care whether they die because of who you are. Help us with this. Has EPA been bumbling, or has EPA been stumped? What is your judgment?

Mr. SCHAD. Senator, granted in everything we do from the time we are born until the last breath we take, there is some risk. When I get up from the table and walk through the door, I may stumble over a chair and fall down. There is a risk in that. It is a very minimal risk.

EPA has not been bumbling in determining the risk. They can develop a risk assessment of how many parts per billion of TCE, for example, are in the water and what the potential risk is, but the problem comes in managing it and setting a standard as to what risk to the population in general is acceptable.

Senator MOYNIHAN. At what point in a gradient, and you stop here.

Mr. SCHAD. That is right, and it is very hard for them to say, this may cause 1 death in 1 million. It is terribly hard for a Federal Government agency to say, we will accept a standard that will permit 1 person in 1 million to die. That is a judgment that nobody wants to make.

Senator MOYNIHAN. That is what I meant. In great knowledge there is great sorrow. You learn about these things.

I wonder if we shouldn't ask EPA to come here and tell us what they have done. You think that it is not a matter of bumbling, but a matter of inherent difficulties.

Mr. SCHAD. It is terribly hard to make a decision under the rules of the Federal Government.

Senator MOYNIHAN. It is a very important issue because if there is one thing for the Federal Government to do, it is to provide that kind of scientific leadership. First of all, there is no point in replicating that 50 times plus Puerto Rico and Guam. It is the same risk everywhere. There is an efficiency in the Federal Government doing it and doing it once and for all.

Mr. REILLY. Senator, I don't know whether this is going to be helpful at all, but I will offer it anyway.

We are in a very complicated area, and I am a lawyer; I am not a scientist. I used to agree with Mr. Ruckelshaus, who is a trustee of our foundation, who has tried very hard to separate the operations of risk assessment, on the one hand, from the job of risk management, on the other. He has done that, I think, for obvious and valid reasons, trying to separate out that part of the job which is technical and scientific, where we have some reasonably objective criteria for success, from the political and policy judgments, the value laden questions such as you were talking about a moment ago.

I must say, the more I am exposed to this issue, the less it seems to me that separation is altogether possible. Certainly, it is desirable. Certainly in practice, we have to do some of it. But if you start asking the questions about risk inherent in a given chemical, and its presence in the water, it raises all the issues of what risks are you concerned about. Do you test for cancer, or do you test for heart disease, or lung disorders, or liver problems, all of which may be affected differently. In fact, there are even some chemicals that appear to do a lot of good in one area, and a lot of bad in another.

There are then the questions of whether animals are reasonable surrogates for determining some of these things; whether you use mice or rats. I was exposed to a research project the other day where the mice had tested one way, and the rats another. Mice were benefited, and rats were harmed by the specific chemical. Then the question is which animal is more likely to be similar to the human response. And so it goes, one question after another, each of which is very much caught up in the job of assigning values, determining what it is we consider important. If EPA has had a difficult job with this, it seems to me that it is because it is a difficult problem, it is one that none of us is very comfortable with facing very directly and being very objective about. I think that it is one of those issues that Congress also has shied away from getting into very specifically.

Senator MOYNIHAN. Would someone else like to speak?

Mr. LOY. Mr. Chairman, I would just say that however difficult this task is, and it is difficult to determine what causes various levels of disease, and where to try to begin to draw the line, I do believe our scheme does not work, at least it doesn't work very well, if the EPA does not do what we have been talking about, because it is not going to be possible for the States to do it, and it certainly isn't, as you have suggested, efficient. Therefore, States are somewhat at sea in trying to determine what are the standards.

This contemplates that they will take the responsibility in building the standards into their State plan, but they don't have the resources and they don't have the knowledge, and it is the function of EPA to help them do that by these risk assessments.

Senator MOYNIHAN. Let me say, I think that we are deep enough into this subject now that I think we will get the EPA in to testify before us.

Could I just invite comments that you might think of, as you are on your way home, dodging traffic, that you might send us in writing. It would be greatly appreciated.

Governor BABBITT. Senator, I would be delighted. I can't stay out of this discussion as hard as I might try.

Mr. Reilly comes, apparently, from the "knowledge brings sorrow" school. We have had these debates before. I come from the "truth shall set you free" school.

We confronted this problem in the wake of Three-Mile Island very intensively, what threshold is radiation acceptable, a very emotional subject. The Nuclear Regulatory Commission, understandably, but not very courageously, retreated behind a fiction that there will be no exposure anywhere, at any time, ever. I would suggest to you, Senator, that we corrupt the public debate when we allow Federal agencies to become artful and evasive. It is our job in these circumstances to move toward reality, rather than away from it, and attempt to speak up to the public rather than down. Therefore, EPA cannot be excused for being artful, as painful as it is to be truthful.

With that, I promise you that you will have a complete digression from Mr. Reilly, from his associates, who are able and competent people, and we will respond to your request.

Mr. REILLY. The only response I would make to that, Senator, is to say that having gone through all of these niceties of risk assessment, I think it makes it more clear why this forum sees it as fundamental that that job be undertaken once, centrally and efficiently, by EPA, rather than 50 times in different ways throughout the country.

Senator MOYNIHAN. I don't want to keep you, gentlemen, since that may be a vote to abolish EPA.

No, we had that vote the other day, as a matter of fact, and it is in conference right now.

I just wanted to make the point that the sort of thing that Governor Babbitt was talking about, the clarity, the Government doesn't do this well. There are two problems. One is the inherent indisposition to say that any risk is acceptable, which is just difficult to do. Second, the problem of science in government. There is not a natural scientist in the whole U.S. Senate. There was one, Jack Schmidt, a geologist, who served a 6-year term. I used to say of him that he was the first natural scientist to serve in the body since Thomas Jefferson presided, and that is literally the case.

We have no inherent capacity to absorb this, and we filter it sometimes through excellent staff, and sometime through only superior staff.

I remember the first time I ever sat in this room, I was way down there, and a 28-year old was solemnly informing this committee of exactly the percentage of increase in skin cancer around the world that would follow from *y* increase of carbon dioxide in the outer-atmosphere. I didn't know that people had discovered that, and that was a wonderful bit of knowledge that someone knew all over the world what was going to happen exactly if you had *x* number of tons of coal, and he knew. That is the problem of knowing things that aren't so.

Can I ask you, you have been very generous with your time, and your very creative work.

Once you do have standards, and you may have some level of discretion, here is your curve, and you can pick your point, if that is the way you want to live. This is one of those issues where States have an inherent interest in acting. You cannot get a jump on some competitor State while having poisoned water. It won't work. You can do it by having low wages, and having no safety standards, and no taxes, and all of those things, but poisoned water doesn't get you much in the way of tourism, or industry, or anything.

Once you get this thing set up, I think it has a self-energizing element. If you can ever get the thing up to be visible. If the Federal Government could put up money for a big hole in the ground that you could look down into. We will put that bill up next year. This year, Senator Mitchell has some questions that he would like to put to you.

Our general ground water bill is S. 1636. If you would be kind enough, those of you who have the energy, have the time, give us your general feelings on that because we are of a mind now, and we think we see the dynamics of this, and we will do so much better because of your work, which is not only public spirited, but it is competent, and those things don't always come together.

We thank you very much. I am sorry that the chairman couldn't return. We are dismantling the Federal Government bit by bit, and it is not easy. It has been here for 200 years, and it is a big wrecking job, but we are making some progress. If we are still here the next time, we will welcome you back, and we will certainly welcome your comments.

Thank you all very much.

[Whereupon, at 3:26 p.m., the subcommittee adjourned.]

[Statements submitted for the record and the report of the National Groundwater Policy Forum follow:]

The Conservation Foundation

STATEMENT
ACCOMPANYING THE RELEASE OF THE REPORT
OF THE
NATIONAL GROUNDWATER POLICY FORUM

by

William K. Reilly
President
The Conservation Foundation

Washington, D.C.
November 14, 1985

Good morning. I would like to welcome everyone to this briefing. Today we are releasing the proposed conclusions and recommendations of the National Groundwater Policy Forum, a private group of leaders and officials from state and local government, environmental organizations, and industry, as well as groundwater authorities. This effort has been conducted under the Foundation's auspices and chaired by Arizona Governor Bruce Babbitt, a member of our Board of Directors. Co-chairing the Forum have been Dr. Jay D. Hair, Executive Vice President of the National Wildlife Federation, and David M. Roderick, Chairman and Chief Executive Officer of U.S. Steel. Dr. Hair will speak shortly. Representing Mr. Roderick is Dr. Philip X. Masciantonio, Vice President for Environmental Affairs at U.S. Steel. Governors Anthony S. Earl of Wisconsin and Thomas H. Kean of New Jersey also are members of the Forum; a complete list of the other distinguished members is in the press packet.

This group has worked diligently since January to develop a strategy for how the country should deal with the increasingly serious problems of groundwater contamination, and most particularly how responsibilities should be allocated among different levels of government. We have developed what we believe is a sensible, workable approach. Governor Babbitt will outline our proposals in a moment.

The contribution of this group to the debate on national groundwater policy comes not only in the substantive recommendations but also in building consensus among the many sectors of society with a stake in groundwater. Cooperative problem-solving and consensus building have been part of The Conservation Foundation's repertoire since 1976, when we began a program to bring environmental and business leaders together to address specific divisive issues, to clarify misunderstandings, and to elevate the level of debate over environmental matters. The Groundwater Forum's report is the latest in an ongoing series of agreements addressing significant environmental issues.

The recommendations of this group, the Groundwater Forum, define a significant new approach to dealing with environmental problems. We recommend treating groundwater comprehensively as a resource rather than taking the traditional approach to pollution problems -- that is, controlling sources of pollution and then cleaning up the mistakes at the other end. Our proposals spell out key elements of a management plan that seeks above all else to prevent contamination before it becomes a serious problem. Our call for action is aimed not only at several levels of government but at private industry and public interest groups as well.

Our proposals also suggest some of the ways in which the politics of water are changing. Perhaps no one illustrates this better than Governor Bruce Babbitt. In Arizona, in the West generally, water is sacred. Over the past several years, a combination of environmental and fiscal constraints have caused environmentalists, water resource managers, and now a growing number of political leaders to come to terms with the need for more intensive management of water. Management, conservation -- today, these are the cornerstones of sensible and effective water policy, whether in federal, state, or municipal policy. Arizona, under the leadership of Governor Babbitt, is showing the way.

It is my pleasure to introduce Governor Bruce Babbitt.

STATEMENT OF GOVERNOR BRUCE BABBITT OF ARIZONA
BEFORE THE
SUBCOMMITTEE ON TOXIC SUBSTANCES AND
ENVIRONMENTAL OVERSIGHT OF THE
SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
NOVEMBER 14, 1985

Mr. Chairman, I am pleased to appear before you today on behalf of the National Groundwater Policy Forum to discuss our proposed recommendations and conclusions which we released just this morning.

The Forum's recommendations represent a consensus developed over a year of deliberations among our seventeen individual members. When we first met in January, we faced a challenge not unlike that before this Subcommittee, to construct from whole cloth a national groundwater policy which respects the wide variations in groundwater use, occurrence, and vulnerability, while affording current and future users an assurance of consistent protection.

A number of principles common to all our members guided our discussions. We concurred that prevention of contamination is always desirable over clean up in light of the difficulty and cost of remedial actions. We shared a common interest in the development of a national program to replace the existing *ad hoc* system of decisionmaking which has left this resource poorly protected. Our challenge was to reconcile these diverse and often conflicting principles in recommending a national strategy.

I believe that the Forum's recommendations meet the mark of recommending a national approach focused on groundwater in its many facets. We have achieved agreement on the form and direction of a national protection effort. The Forum's strategy is distinguished by five features which I would like to leave you with today.

First, we believe that national legislation is needed to protect groundwater quality. No other national resource, important to every state, is managed without a framework for action or an articulated national policy. It is time to state in law the nation's interest in groundwater quality protection.

Second, this groundwater protection effort must be united under a national goal. This concept is far from foreign to our system of resource protection and development. For surface waters we pursue the fishable and swimmable goal. Renewable resources on public lands are managed to achieve sustained yield. The Forum recommends a specific national goal:
to protect the physical, chemical, and biological integrity of the nation's groundwater resources and ensure they are not degraded in any way harmful to humans or the environment. We invite you to review and test this proposal as a target against which our progress in protecting groundwater quality can be measured.

Third, the Forum concurs that adequate groundwater protection can only occur in the context of comprehensive management. We must focus on groundwater and all of its uses as a national resource. We can no longer rely on partial efforts which add up to less than consistent and coherent protection. We recommend ten elements which, taken together, constitute comprehensive state management programs. Each of these activities, be they source controls, classification of aquifers, or state or local land use protection, are not unique. But when considered together, and directed in support of a national goal, they form a framework for resource management which the Forum believes is necessary to achieve adequate protection.

This concept of comprehensive management is founded on the primary responsibility of state and local governments to manage and protect the resource. Yet, responsibility does not rest with them alone. The federal government must provide technical support, ensure consistency among state efforts, and provide inducements for state and local action. Public interest groups and the private sector also share responsibility for groundwater protection.

Fourth, we believe that a forcing mechanism is necessary to ensure that every state acts to protect and manage this resource. Protection of groundwater should no longer be an option. We recommend that the federal government withhold funding under grant programs related to groundwater in states which refuse to act to achieve comprehensive management. The Forum bases this recommendation on the notion that grant monies are not a reward but constitute a public trust. To the Forum, states which do not take essential steps to protect and manage groundwater cannot be expected to uphold this public trust.

Finally, we feel that the diversity of the Forum membership and the credibility of each of our participants add significantly to the validity of our recommendations. Our proposed strategy may not prove to be the definitive answer to the question of how best to protect groundwater. It will, we believe, serve as a catalyst for a healthy and necessary national debate.

These proposed conclusions and recommendations complete the major work of the Forum. We will be testing and advancing them in three public hearings to be conducted next month. Our final report, reflecting public comments, will be released with a background document early next year.

Thank you for your interest in the Forum's activities.

STATEMENT OF FRANK E. LOY

CHAIRMAN OF THE BOARD
ENVIRONMENTAL DEFENSE FUND

BEFORE THE

SENATE ENVIRONMENT AND PUBLIC WORKS COMMITTEE

November 14, 1985

I am pleased to be here today to testify on the Nation's groundwater problems and to comment on the recommendations of the National Groundwater Policy Forum.

I was pleased to serve on the Forum as one of several members affiliated with environmental organizations. I am not, however, a professional environmentalist. My background is in business, government service and the law. The organization whose board I chair, however, has had a long interest in this subject.

Other testimony you have received, and the report of the Forum itself, make clear that America's groundwater is a precious resource. You all know that:

- Groundwater is now the source of drinking water for more than 50 percent of the total U.S. population and for 97 percent of rural residents.
- Of all the water withdrawn for municipal supplies, 35 percent comes from the ground.

- Groundwater is essential for many ecosystems valued for their fish production, wildlife habitat, recreational opportunities, and ecological diversity. In periods of drought, especially, groundwater serves important ecological functions, providing fresh water for many lakes, rivers, inland wetlands, bays and estuaries.

This resource is not now receiving adequate projection, and the Forum report seeks to develop a program to do so. There are three propositions I would like to stress as you consider this report:

First, we are asking this Committee, and the Congress, to do something which is difficult for any legislative body: to address a problem and to legislate at a time when, in the words of the report, "The nation is not yet facing a groundwater crisis." So often, only the presence of such a crisis will yield legislation. But the Forum does recommend in the strongest terms that you address this problem now, because if we do not manage this resource in the near future, we will face a grave crisis; and it will not be long before, in area after area, it will be either difficult or impossibly expensive to restore the quality of the groundwater we now enjoy, and permit us to pass it on to future generations.

Second, I believe the report deserves your careful and sympathetic attention, not only because the recommendations are sensible -- if somewhat cautious -- but also because of the character of the group that produced the report. This is a report which has been found acceptable and desirable by several governors and other state and local officials, by knowledgeable representatives of the American business community (including several businesses whose activities by their nature involve significant threats of pollution), and by several environmental organizations. The fact that this diverse group has been able to issue any report with meaningful recommendations is itself an accomplishment. We owe a substantial debt of gratitude to the Chairmanship of Governor Babbitt for making this possible. If I had written this report by myself, or if any environmental group had written it, the report would be different in some critical respects. (I would guess that is also true if the U.S. Steel Corporation had written it.) But then it probably would not get or deserve the attention which this consensus report deserves and hopefully will get. We are fully aware that when trying to deal with this environmental problem, as with most problems of this nature, there are competing national interests at work, and that the Congress in the end must resolve them. While we have made some compromises in achieving this unanimous report, we have made none that we believe are fatal or unacceptable.

Third, the Forum recommends a quite carefully constructed partnership between different levels of government. The nature of the resource, it says, requires states to bear primary responsibility for management of the groundwater resource. But a crucial federal role is envisioned; without it, the resource will not be adequately protected. This committee obviously must ask itself just what this federal role should be.

The role is more limited than in other environmental laws for several reasons. One is that the localized nature of groundwater resources makes it hard to legislate nationally and uniformly. Second, quite frankly, is that there is some fear on the part of the business community, and some local officials, of a statute, like the Clean Water Act, that provides a detailed and primary federal role.

I believe, in fact, that we can do without such a federal role if -- as is recommended in the report -- the federal government is given enough muscle to get the job done.

That requires a federal role with six components:

The first establishes in federal law a strong groundwater protection goal to which the entire nation aspires: to protect the physical, chemical, and biological integrity of the nation's groundwater resources and to ensure that they are not degraded in any way that may be harmful to humans or the environment.

The second component is the clear definition in federal law of the elements of an adequate state groundwater protection program. Although states must be able to design programs that respond to their particular needs, we believe that every state program must include, at a minimum, six basic elements: mapping, classification, ambient standards, source controls, monitoring, and enforcement.

The third federal responsibility is to give the Environmental Protection Agency the authority to determine the adequacy of the state programs. This can be a straightforward and rapid process if Congress clearly defines the required program elements in the enabling legislation.

The fourth component is a set of strong inducements -- particularly citizen suits against recalcitrant governments and the withholding of key federal grants and programs -- which will stimulate the states to adopt and implement the types of programs that are needed. Many states undoubtedly will adopt the necessary programs fairly promptly, but it is simply being realistic to recognize that some will need further prodding.

The fifth component is adequate federal financial and technical assistance to the states -- initially for all states, but thereafter only for those that adopt acceptable programs. Technical assistance activities should involve both EPA and the U.S. Geological Survey and should include aid in determining how to control contamination sources that are not currently adequately controlled; in adequately defining the groundwater resources that the states are trying to protect; in establishing groundwater quality standards adequate to met the national goal that the Forum recommends; and in monitoring the quality of the groundwater, assuring that the programs are working properly and the health of the American people is being protected.

The final component is periodic oversight of the state programs. EPA and the Geological Survey will provide some oversight in the course of their financial and technical assistance. But the other type of oversight we recommend is by a review commission - composed of a mix of intersts similiar to those represented on the forum -- which EPA and the states will establish every five years. In the long run, such public reviews may be one of the more important innovations recommended by the Forum, and we at the Environmental Defense Fund look forward to participating in them.

Senator, this completes my prepared remarks. I will be happy to answer any questions that I can.

STATEMENT OF PHIL MASCIANTONIO
VICE PRESIDENT-ENVIRONMENTAL AFFAIRS, U. S. STEEL CORPORATION
ACCOMPANYING THE RELEASE OF THE REPORT OF THE
NATIONAL GROUNDWATER POLICY FORUM

NOVEMBER 14, 1985

I AM PLEASED TO BE HERE TODAY. I AM REPRESENTING DAVID RODERICK, CHAIRMAN AND CHIEF EXECUTIVE OFFICER OF U. S. STEEL CORPORATION, WHO SERVED AS VICE CHAIRMAN OF THE FORUM. MR. RODERICK WOULD HAVE BEEN WITH US THIS MORNING BUT FOR A LONG-STANDING COMMITMENT.

MR. RODERICK AND I HAVE PARTICIPATED IN THE DELIBERATIONS OF THE GROUNDWATER FORUM FROM THE START. TODAY, WE ARE TAKING PART IN RELEASING THE PRODUCT OF THIS EFFORT. AS I THINK ABOUT OUR INVOLVEMENT AND ITS IMPLICATIONS FOR INDUSTRY AND THE COUNTRY GENERALLY, THREE POINTS WARRANT SPECIAL ATTENTION IN MY VIEW.

FIRST, I BELIEVE THIS ATTEMPT AT BUILDING CONSENSUS ON POLICY OFFERS A SIGNIFICANT PRECEDENT. TOO OFTEN IN THE PAST, DIFFERENT PARTIES HAVE DRAWN HARD-AND-FAST LINES ON POLICY ISSUES. IN SUCH A POLARIZED SITUATION, IT IS VERY DIFFICULT TO SEEK COMMON GROUND, TO CONSIDER TRADEOFFS, TO NEGOTIATE, TO STAY FLEXIBLE -- IN OTHER WORDS, TO DO THOSE THINGS THAT CAN LEAD TO A REASONABLE SOLUTION TO A SIGNIFICANT ENVIRONMENTAL PROBLEM.

My experience with the Forum demonstrates that a cooperative approach to environmental problem-solving is possible. Through discussion and analysis and negotiation, we have developed a consensus position on a serious issue -- protecting groundwater -- that takes account of a variety of points of view.

Environmental policy does not have to be a win/lose situation for anyone. American industry has a large stake in groundwater, as do many others. Economic growth and productivity can depend on having adequate water supplies. It is in our best interest to cooperate in protecting groundwater. But we want to see it protected in a way that lets us know in advance what's expected of us, and in a way that's cost-effective. The Forum's proposals score high in this regard. To U. S. Steel, they represent a sensible allocation of responsibilities. They let each level of government, as well as the private sector, do the job each does best.

And that leads to my second point: Protecting groundwater demands a new kind of environmental partnership among levels of governments. The Forum's report states, "Most groundwater supplies in the United States are of good quality. The nation is not yet facing a crisis." In other words, the Forum concluded the country does not need a crash program of federal regulation. The Forum is not calling for a replication of the Clean Air Act or the Clean Water Act, which addressed near-crises situations.

Groundwater represents a different kind of challenge than environmental policy has faced before. The Forum looked hard at the complex issues in groundwater management, and concluded that the occurrence, condition, and uses of groundwater are distinctly local problems, demanding local solutions. While some state governments may need encouragement to act, they also need flexibility to respond to local situations, as well as federal support in research, data gathering and program development. The Forum's proposals give them both. And that seems to me to open up a whole new approach to federal-state relations in environmental management.

The final point I would stress is that the Forum has challenged American industry to do a better job in reducing wastes. Waste reduction, through recycling, materials and process changes, and other methods, represents a frontier whose potential industry is starting to explore. It promises to be one effective means of preventing groundwater contamination.

That's our job. The report says, "everyone has a job" to do. It all adds up to a common sense, realistic approach to managing our groundwater resource.

Thank you.

Groundwater
Saving the Unseen Resource

Proposed Conclusions and Recommendations

November 1985

The National Groundwater Policy Forum

Sponsored by The Conservation Foundation in cooperation with
the National Governors Association

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The National Groundwater Policy Forum

The National Groundwater Policy Forum was convened and sponsored by The Conservation Foundation, in cooperation with the Forum's chairman, Governor Bruce Babbitt of Arizona, and the National Governors Association. The Forum's goal is to articulate a thoughtful, organized, persuasive national program for groundwater management and protection, assigning responsibilities among all levels of government and the private sector. It has been created to be independent of established institutions and the current impasse on groundwater policy, yet to have sufficient prestige—in its membership and the quality of its work—to influence the course of groundwater protection across the nation. In formulating these proposals, the key decisions were made at Forum meetings during 1985, with further refinements made by Forum staff in close consultation with top staff representatives designated by the Forum members. The proposals thus were the product of an extensive, continuing process of revision and reflect the genuine consensus that has been built over the past year.

This document is the principal product of the Forum's deliberations. It is hoped that the recommendations and conclusions it contains will provide a focus for the much-needed discussion about groundwater policy that has begun in recent months. Of equal importance is its agenda for concerted, nationwide "action now," before localized problems become a national crisis. Accordingly, the Forum has scheduled public hearings (for December 1985) in diverse regions of the country to increase awareness of the issues and to stimulate a debate on its agenda for action. This document will then be further revised, and the final recommendations and conclusions of the Forum will be published in the spring of 1986. The published volume will also include background material on the contamination problem and a summary of the hearings.

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Overview

Groundwater flows largely unseen beneath the surface of the earth. Like the arteries of a living organism, it bears nourishment to human populations and ecological communities. It supports economic activities as critical as food and energy production, as diverse as mining and manufacturing. This vast underground reservoir is replenished by surface water, precipitation, and direct discharges. Its quality and utility are threatened by some of the most mundane human activities.

While the national extent of the threat to groundwater is not known definitively, thousands of well closures have occurred throughout the country. More than 200 organic and inorganic chemicals have been identified in various groundwater supplies. Increased costs can be measured for finding new sources of fresh water, pumping it from more remote locations, and providing increased levels of treatment to meet standards for safe consumption.

Recent federal legislation has begun to restrain certain activities particularly damaging to groundwater. Some states have individually implemented aggressive protection programs. And the groundwater protection strategy recently adopted by the U.S. Environmental Protection Agency is a welcome first step. But this regulatory patchwork provides inadequate protection and largely fails to address directly the complex technical, economic, and political demands of groundwater management.

The variability of groundwater resources—their geographical occurrence, physical and chemical properties, uses, and sources of contamination—demands local flexibility. At the same time, efficient deployment of resources, maximization of technical expertise, and economic competition among states require a significant role for the federal government. The challenge lies in finding a workable strategy that combines the best of both approaches.

The National Groundwater Policy Forum was formed to respond to this challenge. Our membership encompasses the distinct and often competing interests of farmers, industrialists, politicians, administrators, academics, and environmentalists. This breadth of perspective is unmatched by any single-purpose organization. This diversity has equipped us to forge a credible consensus on a forceful new agenda to protect the country's groundwater. Our agenda consists of the following key elements.

A New Environmental Partnership

We propose a new environmental partnership to pursue the goal of groundwater protection. Many of the existing environmental statutes create a fundamental federal responsibility for resource protection while delegating certain authorities to the states. We believe that groundwater must be treated differently. The nature of the resource dictates that states must bear the primary responsibility for its management, with local governments bearing a major responsibility for program implementation. The proper role of the federal government is to assure consistency and equity among the states by stimulating state and local action, and to provide technical support and oversight.

However, the demands of groundwater protection require that we recognize the critical roles of two other partners. The private sector should assume the tasks of reducing the generation of wastes through process modification, resource recovery or recycling, or materials substitution and of undertaking research into improved technology for hazardous waste neutralization. Environmental organizations and other public interest groups should educate the general public about the nature of the groundwater problem and assure responsive actions by appropriate parties.

Comprehensive Management

We urge every state that has not already done so to enact legislation to affirm the public interest in groundwater protection and adopt the comprehensive programs necessary to manage groundwater effectively. It is essential that groundwater be afforded the strong protection that has been provided to other vital natural resources.

Moreover, we believe that the focus on source controls and cleanup that characterizes many of the nation's existing environmental laws will not suffice to provide the protection this valuable resource requires. Instead, we recommend that states adopt true resource management programs which incorporate but extend beyond traditional pollution control approaches.

These programs must be based upon an improved understanding of the resource itself—the physical dimensions and hydrogeological properties of the aquifers, and the quality and quantity of water available—as well as better knowledge and control over the uses of groundwater and the threats it faces. The programs should also integrate the management of withdrawals with the protection program and combine surface-use restrictions and source controls to protect sensitive wellfields and recharge areas. Groundwater management efforts must be closely coordinated with other environmental protection and natural resource management programs.

National Legislation

We recommend that Congress embody the intent of groundwater management in federal law by declaring that the goal of the United States is to protect the physical, chemical, and biological integrity of the nation's groundwater resources and ensure that they are not degraded in any way that may be harmful to humans or the environment. The importance of groundwater to the national quality of life requires that the country aspire to the highest and best end of preventing its contamination.

We recommend that the federal statute which establishes the national groundwater protection goal require the states to enact programs to achieve that goal. Our recommended legislation would also allow for limited reviews of the state programs, provide technical and financial assistance to the states, and create inducements to states to take effective action quickly.

We do not believe, however, that the federal government needs to create a whole new regulatory process or large bureaucracy to carry out these responsibilities. If, for instance, additional federal regulatory action is necessary to control serious potential sources of contamination, we believe that such action can, in most cases, be taken under other statutes already in existence.

Conclusion

This country is indeed fortunate that groundwater contamination has not yet reached critical proportions. Vast areas of groundwater remain largely unimpaired. To maintain them, Americans must do more than diligently clean up past contamination and control individual pollution sources. A new environmental partnership consisting of state and local governments, the federal government, private industry, and public interest groups must dedicate itself to the comprehensive management of groundwater as a resource. State and federal laws must be enacted to define the goal of groundwater protection and to authorize and fund the necessary strategies to achieve that goal. If the nation is to fulfill its duty to assure that future generations have adequate supplies of uncontaminated groundwater, it must act forcefully, and act now.

The Groundwater Contamination Problem

The quantity of groundwater underlying the continental United States is immense. That which can be retrieved with current technologies is at least six times greater than all the water stored in our surface lakes and reservoirs. The amount within half a mile of the surface is equal to about 35 years of all surface water runoff or about 400 times annual consumptive use.

People depend upon groundwater in every state. It now provides almost one-fourth of all water used in the country, serving these important purposes:

- Of all the water withdrawn for municipal water supplies, 35 percent comes from the ground.
- Groundwater is now the source of drinking water for more than 50 percent of the total U.S. population and for 97 percent of rural residents.
- Groundwater accounts for some 40 percent of all agricultural irrigation water and 26 percent of industrial withdrawals (excluding electric power plants).
- Groundwater nourishes and maintains many ecosystems valued for their fish production, wildlife habitat, recreation opportunities, and other attributes. In periods of drought, especially, groundwater serves important ecological functions, providing fresh water for many lakes, rivers, inland wetlands, bays, and estuaries.

Most groundwater supplies in the United States are of good quality. The nation is not yet facing a groundwater crisis. In some localities, however, contamination has caused well closures, public health concerns, and economic losses. These problems could spread. The challenge is to prevent these threats from creating a crisis.

Groundwater can be easily contaminated in a multitude of ways, including some of the most ordinary human activities. Among the most prevalent sources of contamination are (1) waste disposal; (2) storage, transportation, and handling of commercial materials; (3) mining operations (some of which involve the disposal of mining and processing wastes); (4) agricultural operations; and (5) other nonpoint sources.

Our groundwater resources have long received very little attention. For one thing, it was thought that the natural filtering capacity of soils simply removed dangerous contaminants. Also, because most contamination is hidden underground, and because most contaminants require a long time to reach wells, public awareness of the problem is limited. In fact, until recently, the ground was actually thought to be the best place to get rid of wastes. The preferred method of disposing of hazardous wastes, for instance, has been to place them in landfills or inject them underground.

However, several federal statutes dealing with various sources of groundwater pollution have been enacted in recent years. The Safe Drinking Water Act includes programs to regulate the quality of drinking water at the tap from ground or surface sources, to regulate the underground injection of wastes, and to protect particularly essential and vulnerable aquifers that are sole sources of communities' drinking water. The Resource Conservation and Recovery Act controls the generation, treatment, storage, and disposal of hazardous wastes. It also regulates underground storage tanks to prevent leaks.

Other federal laws dealing with surface-water quality, strip mining of coal, pesticide regulation, and cleanup of abandoned hazardous waste sites can also control some sources of groundwater pollution. Some states have adopted more comprehensive groundwater protection programs, imposing additional source controls and using a variety of planning and regulatory techniques.

In most cases, however, groundwater protection efforts have been partial at best. The regulatory programs put in place often have failed to exercise much of the statutory authority available. Because many of the laws were written at different times and for different purposes, they often add up to a program of groundwater protection that is neither coherent nor consistent, even if those laws are implemented to the limits of the enacted authority.

The U.S. Environmental Protection Agency has recently adopted a strategy that attempts to coordinate the laws for which it is responsible. While this is a useful step in reforming the federal protection of groundwater, the nation is still left with a haphazard patchwork of laws, and some contamination sources remain uncontrolled.

Once aquifers are contaminated, remedial action is extremely costly, and may not be technically feasible in some instances. Cleanup can require many years, can cost millions (and in some cases tens of millions) of dollars, and still may not completely solve the problem. In addition, some cleanup techniques can result in the release of toxic pollutants into the air or the creation of other toxic wastes that, if improperly handled, again become a source of groundwater contamination.

Substantial efforts are currently under way to address cleanup problems and to protect groundwater users from the adverse effects of existing contamination. Instead of reexamining these efforts, we direct our recommendations to the future—toward developing and implementing adequate measures to prevent contamination in the first place.

A Groundwater Protection Strategy

The National Groundwater Policy Forum concludes that the nation must adopt a much more aggressive policy of groundwater management if it is to protect this resource adequately for current use and for future generations. Formulating and implementing such a policy may be one of the most difficult environmental tasks the country has had to face.

To address this complex problem effectively requires a highly coordinated attack at national, state, and local levels. It must take advantage of the management capacities of different units of government as well as engage the active cooperation of the private sector and public interest community. It must involve a partnership committed to achieving a common goal of protecting the critical groundwater resource.

We recommend that the nation adopt as its goal: to protect the physical, chemical, and biological integrity of the nation's groundwater resources and ensure that they are not degraded in any way that may be harmful to humans or the environment. We further recommend that this goal be decreed in state and federal law.

This goal and our subsequent recommendations are based on the following principles:

- that groundwater must be actively managed, not left to *ad hoc* decision making, if the resource is to continue to meet human and ecological needs;
- that contamination should be prevented wherever possible because of the technical difficulties and economic costs involved in cleanup;
- that degradation of the most valuable aquifers and critical water supplies should be prevented; and
- that any national groundwater program must recognize wide variation across the country in the nature, vulnerabil-

ity, and use of groundwater, as well as in the capacity of states and local governments to manage it.

Rising to the Challenge

The localized nature of groundwater resources demands a new environmental partnership that avoids the burdensome bureaucracy which has often accompanied past federal environmental legislation. Such a partnership obligates states to act, while providing them substantial flexibility to design programs responding to their specific needs. Such a partnership requires the federal government to balance the concern for national consistency with the reality of geographic differences. Such a partnership demands maximum participation and creativity from local governments, private industry, and public interest groups.

The great variations in the characteristics of the groundwater resources themselves, in the threats to which they are exposed, in the uses that are made of them, and in the institutional capabilities and mechanisms available for their protection all dictate that states must assume the primary responsibility for protecting the nation's groundwater. This responsibility should be assumed within a new type of federal-state relationship that simultaneously sets forth a clear national mandate and ensures the states ample room to operate.

The keystone of this partnership should be state programs that manage groundwater comprehensively as a resource, not letting its protection be splintered among many uncoordinated laws and agencies. To this end, we recommend that every state which has not already done so enact legislation to authorize and implement a comprehensive groundwater protection program incorporating the groundwater quality goal recommended above and including the 10 following components:

1. comprehensive mapping of aquifer systems and their associated recharge and discharge areas;
2. anticipatory classification of aquifers;
3. ambient groundwater standards;
4. authorities for imposing controls on all significant sources of potential contamination;
5. programs for monitoring, data collection, and data analysis;

6. effective enforcement provisions;
7. surface-use restrictions to protect groundwater quality;
8. programs to control groundwater withdrawals so as to protect groundwater quality;
9. coordination of groundwater and surface-water management; and
10. coordination of groundwater programs with other relevant natural resource protection programs.

We recognize that states often lack the technical and financial capability to initiate, unassisted, a new and complicated environmental management program. For this reason, we recommend that Congress appropriate funds for the U.S. Environmental Protection Agency (EPA) to use to provide technical support and make matching grants to the states to help them initially develop their comprehensive groundwater programs.

When a state has completed the development phase of its groundwater program, we recommend that it be authorized to apply to EPA for matching grant funds to undertake its implementation. EPA shall presumptively find the state program to be adequate as a basis for such a grant if it finds that the state program contains legislative authority and resources for implementing at least the first 6 of the 10 components in a manner consistent with the goal recommended above. We recognize that some states may decide not to include one or more of the other four components of the program because of political, legal, or institutional obstacles. In such cases, we recommend that the state be required to justify each exclusion.

States should consider offering technical assistance as well as financial inducements to local governments to help them carry out their responsibilities under comprehensive management. States also should provide legal authority for local units of government to implement land-use controls where these may be necessary to further protection goals.

States should be sure that their actions reflect the great variation in local government capabilities. In delegating responsibilities and in taking enforcement actions, the states should exercise discretion to distinguish among local governments rather than trying to impose inappropriate, uniform conditions on all local governments.

Local governments often experience the groundwater contamination problem most directly because they are responsible for providing safe drinking-water supplies. They must ensure that these supplies remain potable and should be prepared to take prompt action to prevent damage to public health if contamination occurs.

Localities must also ensure that such potential sources of contamination as landfills and municipal sludge disposal for which they are directly responsible are adequately controlled. In addition, they are best able to regulate certain other potential contamination sources such as septic tanks. They must control these sources as well as implement other parts of their states' management programs. Finally, local governments should amend their zoning and other land-use controls to make them consistent with, and no less protective than, the management program adopted by their state.

If the states and localities effectively implement the programs we recommend, the role of the federal government will be limited but no less important in establishing the national framework for groundwater management. We therefore recommend that Congress clearly delineate the federal role by enacting legislation which establishes the national goal recommended above and requires each state to establish a comprehensive groundwater management program. The legislation should specify that the first six components of a state program are mandatory while the last four are desirable but discretionary, and should authorize federal agencies to provide technical and financial assistance to the states.

The legislation should assign to EPA a duty to determine that each state's proposed program is supported by legislation implementing the six required components in a meaningful form that furthers the recommended national goal; to comment on a state's justification for not including any discretionary element; to convene and support the periodic state program review committees discussed below; and to conduct sufficient oversight of the state program itself to ensure that the states are making effective use of their implementation grants.

We also recommend that in authorizing EPA to provide continued technical and financial support to the states, Congress specifically instruct EPA to evaluate the need for, and the techniques of, controlling sources of contamination that are not adequately regulated under current federal statutes. Congress should also require EPA to recommend health-based ambient groundwater guidelines for potentially toxic compounds found in groundwater. These guidelines should be based on toxicology reviews to be conducted by an independent scientific body such as the National Academy of Sciences. The legislation should also urge the U.S. Geological Survey (USGS) to direct its Cooperative Program toward support of state groundwater management efforts. Congress should provide adequate funding for EPA and the USGS to carry out their responsibilities and to provide research and technical assistance to the states, at present levels of funding as a minimum.

Finally, the statute should include provisions for effective coordination of the federal groundwater program with other environmental and water resources management programs. It should also include deadlines and incentives that are adequate to induce all parties to implement their program requirements promptly and effectively.

Without active cooperation by private enterprise, the nation's efforts to protect groundwater could generate unnecessarily burdensome and costly regulation. Thus, private industry faces the challenge of undertaking initiatives that provide protection without stringent regulatory control. As with other aspects of pollution control, the most effective approach is often to eliminate the production of wastes and the use of toxic substances that threaten groundwater integrity. Such initiatives might include voluntary equipment, process, product, and development standards for groundwater protection; the implementation of such standards through expanded testing and certification; periodic environmental audits of facilities to identify problems; and better training of personnel to alert them to potential groundwater contamination problems and ways of avoiding them.

Public interest organizations should assist in identifying priority protection areas; educating the public about limiting residential uses of fertilizers, pesticides, and other products; promoting recycling programs; providing oversight of the implementation of government programs; and assessing the efficiency of groundwater protection efforts.

The federal legislation should provide that, once state programs are initially adopted, EPA continue to make technical assistance and program implementation grants available to the states so long as they are implementing their programs effectively. To aid the states in their implementation and to aid EPA in its review, we recommend that each state's program be reviewed once every five years to appraise the strengths and shortcomings of its performance. To reflect the importance we attach to the new environmental partnership, we recommend that these reviews be carried out by committees appointed jointly by EPA and the states. Each one should include representatives from federal, state, and local government, as well as public interest groups, professional organizations, and businesses operating facilities or undertaking development in that state.

The committees should review the adequacy and effectiveness of state programs, recommend improvements, and commend particularly successful efforts for other states to consider. As part of this review process, the committees should hold public hearings with extensive citizen input. They should report their findings and recommendations to the state governors and legislatures, to Congress and EPA, and to other federal and state regulatory bodies. EPA should use the findings and recommendations of this committee as a basis for continuing implementation grants or discontinuing them unless a state makes appropriate changes in program authorization or implementation.

Managing the Resource

Most current efforts to protect the nation's groundwater have focused primarily on controlling contamination from specific sources of pollution. While such efforts obviously are important, we believe that they are only one of the elements in truly effective groundwater protection and management. Comprehensive groundwater management should include all of the following elements.

Aquifer Definition

An important step in implementing an effective groundwater management program is to obtain clear descriptions of all significant acquifers. We still know relatively little about the characteristics of aquifers in many areas of the nation. In most cases, more information is needed about their physical configurations including their boundaries and linkages between aquifers; their hydrological characteristics; their chemical properties; the sensitivity of their recharge and discharge areas; the location of current wellfields; the rates of recharge and discharge; and the location of pockets of highly saline or other contaminated water within them.

States should expand their efforts to define adequately the resource they are attempting to protect. The USGS should assist the states in this effort. Preliminary investigations should focus initially on those aquifers that are current or potential drinking water sources and particularly on those areas that contain fields of drinking water supply wells. In addition, the states should collect detailed information on current uses being made of their groundwater supplies and on the location of potential sources of contamination.

However, implementation of the rest of a groundwater program should not be delayed until all this information is available. Rather, the program should be designed to make the best use of available information while providing adequate flexibility to incorporate modifications as more information is produced.

Classification

A well-considered system for classifying groundwater resources is an essential tool to help agencies manage these resources more effectively, with respect to both the prevention of future contamination and the management of contamination that has already occurred.

The nature of the classification system should be optional with the states. States can use classification to identify critical drinking water and other particularly sensitive aquifers for priority protection, to delineate groundwater zones that do not have adequate yields of suitable quality for drinking water use, and generally to help establish priorities and articulate a basis for the efficient allocation of program resources and for sound land-development patterns. Classification can be particularly useful in making decisions on the location of potential pollution sources that, no matter how stringent the design criteria, may leak or result in accidential spills. Realistically, it is extremely expensive to monitor and completely control every significant potential polluter of groundwater. Thus, protection priorities implicitly will be set, if only by choosing to monitor and control in some areas more than in others.

We do not, however, believe that a classification system should allow large areas to be expendable as dumps for civilization's wastes. It is inadvisable to "write off" aquifers that may be needed by future generations. In addition, uncertainties about aquifer hydrology might result in wastes placed in one area migrating, over time, until they contaminate areas designated for drinking water purposes. But these problems are not inevitable consequences of a classification system.

A classification system can be either reactive or anticipatory. An anticipatory classification system will be more efficient and protective than a reactive, or passive, system. In the latter, the groundwater at a specific site is not classified, and the controls to be applied at that site are not defined, until a regulatory decision on a new potential source of pollution is made. This is the way in which the classification system adopted by EPA operates. Reactive systems are of little use in guiding state and local efforts to manage aquifers and control land use because the classification is undertaken only on an *ad hoc* basis in reaction to facility siting proposals. Thus, they do not serve the desired, broader management policies and interests. Moreover, although some firms may benefit in the short run by being able to locate facilities where they wish, reactive systems can substantially increase the uncertainty, delay, and cost associated with development decisions.

We endorse anticipatory classification in which aquifers are mapped as soon as the necessary data are available and in which the applicable regulatory requirements are defined in advance of any regulatory decisions at a specific site. This should provide maximum guidance to communities, water supply managers, and potential polluters by identifying the high-value aquifers as well as those that may be less vulnerable or require less regulatory attention.

We recommend that each state classify all of its potentially usable groundwater. This scheme need not be the same as that adopted by EPA. Some states may wish to classify all of their aquifers as present or future sources of drinking water, thus, in effect, placing all of their groundwater in one class. The states should, however, relate their system to EPA's so that EPA can implement its regulatory responsibilities in a manner consistent with the state program.

Ambient Quality Standards

Ambient quality standards are numerical limits for contaminant concentrations in groundwater. States can employ ambient standards for a range of purposes to reflect their particular management, classification, and regulatory strategies, with each purpose involving distinctive approaches to sampling ambient quality. For instance, they can use standards to trigger controls on sources of contamination and to gauge the effectiveness of limits on discharges that cannot be measured, such as those from nonpoint pollution sources. Florida uses ambient standards for such purposes as checking that the percolation water from groundwater recharge projects does not unduly taint the overall quality of its aquifers. Wisconsin has adopted a two-level standard: an "enforcement standard," the violation of which triggers immediate control or, if necessary, closure of the pollution source; and a "preventive action limit," a point (set at a specified fraction of the enforcement standard) at which control actions are stimulated to prevent future violation of the enforcement standard. We recommend the establishment of proper ambient quality standards as an important element in effective groundwater management.

Several states already have adopted numerical standards for different classes of aquifers and for different contaminants. Having each state develop standards independently not only involves substantial duplication of effort but can create serious uncertainties and inconsistencies as well, leading to frequent legal challenges and delayed protection.

Proper ambient quality standards that protect water users adequately without imposing excessive economic costs on society need to be based on scientific risk assessments. These should take into account not only the toxicity of the compounds but also the chemical, biological, and physical behavior of contaminants under diverse aquifer conditions. Many states are not well equipped to conduct such analyses. Thus, we recommend that EPA in consultation with the states contract with a competent scientific body such as the National Academy of Sciences to assess the potential effects of human exposure to contaminants as well as their ecological impacts. These risk assessments should indicate the range of contaminant concentrations that would be acceptable for different current or potential groundwater uses. EPA should then use these risk assessments as the bases for issuing recommended ambient quality guidelines for potentially toxic compounds. States should use these guidelines as bases for setting standards consistent with the objectives of their classification systems.

Controlling Sources of Contamination

Adequate controls on point and nonpoint sources of potential contamination are an integral part of any effective groundwater protection program. There are essentially two ways of imposing such controls. The first is to impose management or facility controls that prevent or reduce the discharge of contamination by a source located in a groundwater recharge area. This is the approach emphasized by EPA and many state agencies—for instance, when they impose controls on hazardous waste disposal facilities. The second method is to prevent potential sources of contaminants from being located in these areas. Both approaches can be used together. For example, a potential pollution source might not be allowed to locate in an aquifer recharge area unless extraordinary measures are taken to prevent contamination from occurring. The level of government that should be responsible for implementing source controls will vary from case to case.

Discharge Controls. Government can adopt a wide variety of facility or management controls to reduce threats of contamination. Suffolk County, New York, for example, requires that underground storage tanks be double-lined and contain an integral spill-detection mechanism. A Wisconsin statute provides 50 percent state funding for the replacement of inoperative or antiquated septic tanks for residents of counties that have adopted ordinances requiring annual inspection and pumpage of septic tanks. Florida, Connecticut, and Montana use facility performance standards where soil filtration can be effective in removing contaminants—primarily those from septic tanks, cooling water, and urban stormwater runoff. These states bar the technique's use entirely for toxic wastes. New Mexico regulates all discharges to groundwater—except those from agricultural practices and oil and gas production—through a rigorous review of required discharge plans. These plans must include extensive provisions for control, monitoring, and reporting, even after facility operations terminate.

Many sources are already subject to strict control under a variety of federal statutes. But a number of sources, particularly nonindustrial sources, are now not being adequately controlled or not being addressed at all. We recommend that EPA and the states review all types of sources that are commonly not adequately controlled to determine: (1) the potential risk they now present or may present in the future; (2) the availability and feasibility of actions that could be taken to control that risk, including source reduction and recycling; and (3) the cost and impact of control actions compared to the amount by which such actions could be expected to reduce that risk. In most cases, states will be able to use such assessments to develop efficient control strategies. If additional federal controls are appropriate, these could most likely be adopted under existing federal statutes.

There may also be important opportunities for EPA to cooperate with industry in developing and demonstrating techniques that reduce the volumes of waste generated or the danger of spills and other threats. Such techniques could include product substitution and reformulation and changes in process engineering. Recycling programs should be strengthened at all levels of government and in private industry so that wastes can be put back into productive use. Congress should periodically examine the effectiveness of industries', EPA's, and the states' efforts in waste reduction and recycling and if necessary strengthen existing laws or enact new ones to ensure that this issue is elevated from rhetoric to action.

Surface-Use Restrictions. Consistent with their aquifer classification scheme, state and local governments also can use measures such as zoning, controls over facility siting, and public acquisition of land to protect aquifer recharge areas. Suffolk County, New York, has placed about 45 percent of its land area off limits to certain industrial handlers or users of hazardous waste to protect the aquifer that is the county's only source of drinking water. In at least two cases, states have reclaimed from local government some politically sensitive and controversial power over land use to counter specific, serious threats to vulnerable groundwater resources: the Pine Barrens of southern New Jersey and the Edwards Aquifer, sole source of drinking water for San Antonio, Texas.

Zoning, subdivision, or site plan review ordinances can also be used to minimize the danger of contaminating groundwater by calling for more stringent control technologies in the most vulnerable recharge areas. The government may bar certain activities or types of dischargers entirely. Or the government may acquire land (or the development rights to land) to prevent any threatening development.

These approaches do have the drawback of being inflexible and excluding certain uses even if developers could stay within ambient standards. But they are clear and predictable, and they avoid the risk that a vulnerable aquifer will be contaminated by a development which violates, even unintentionally, the prescribed discharge limits.

Comprehensive land-use planning and regulation touch raw political nerves in most parts of the country, and we do not support national land-use controls. However, we do believe that sensitive land-use planning and appropriate controls adopted at the state and local level are eminently adaptable to a wide variety of local groundwater conditions and can be responsive to a similar variety of political concerns. Therefore, we recommend that state and local governments review their existing zoning and other land-use control programs to ensure that they are being implemented in a manner compatible with groundwater protection needs and to determine if those programs need to be modified to improve protection--particularly protection of vulnerable aquifers and critical recharge areas.

Monitoring, Data Collection, and Data Analysis

The success of groundwater management policies depends upon an adequate base of knowledge. For example, a state cannot determine whether its groundwater standards are being met or whether public health and the environment are being protected without a groundwater monitoring program. Yet information about groundwater quality, and about the role of groundwater in the hydrologic cycle, has lagged far behind our knowledge of water in the atmosphere and on the surface. The past two decades have seen increased spending for research applicable to groundwater management, but we believe that substantially more information is needed.

It is essential that data be collected and analyzed using consistent and rigorous procedures for quality control and quality assurance. Data should also be evaluated and made available in a form that can be readily marshalled to support sound decision making. Each state should be responsible for adopting a data-collection strategy that best serves its groundwater protection efforts. The specific surveys and monitoring system most appropriate for a state will depend on the hydrogeologic characteristics of its aquifers, the nature of the threats to them, and the type of management program adopted. In some cases, rather than concentrating on the quality of the groundwater itself, it may be more effective to use available resources to define hydrogeologic conditions and to identify potential sources of contamination in advance by monitoring land use and analyzing soil samples from the unsaturated zone above the groundwater.

The USGS and EPA should assist the states to design and carry out efficient monitoring schemes. These agencies should be responsible for defining quality assurance procedures governing each step of the monitoring process. Also, individual states should collect and store their data in a consistent manner so that information is easily accessible to adjacent states sharing common aquifers.

Nevertheless, we do not believe that a comprehensive national monitoring program and a national data base on groundwater quality is necessary. Such a program would be extremely expensive and of limited value. No affordable monitoring scheme could usefully characterize the quality of the nation's groundwater, since contamination problems typically are localized.

Compliance Enforcement

To assure compliance with groundwater protection requirements, state and local governments must have adequate legal authority to act against violators. An enforcement program may include a range of specific legal tools from administrative orders to civil and criminal penalties.

To the extent that state and local agencies themselves either operate sites or undertake certain actions that may cause groundwater pollution, they should be subject to appropriate enforcement. Also, states should be empowered to ensure compliance from federal agencies such as the Department of Defense (including the Army Corps of Engineers), the Bureau of Land Management, and the Department of Energy, which have in numerous cases failed to control contamination on lands they own or from facilities they operate.

Program Integration

To increase their effectiveness, federal, state, and local groundwater management activities should all be closely coordinated and integrated with other environmental and natural resource programs that affect groundwater resources. Integration with programs that control the allocation and use of groundwater, and with surface-water programs, is particularly important. These activities should also be carefully coordinated with programs that control potential sources of groundwater contamination as well.

Withdrawal Control. The Forum, recognizing that controlling groundwater withdrawals is a state responsibility, does not recommend that current authorities be modified. However, we also recognize that the management of groundwater quantity can have important practical repercussions for groundwater quality. Excessive pumping from wells can speed the spread of a contamination plume through an aquifer. Or it can draw low-quality water into the aquifer from coastal areas or adjacent salt-water aquifers. Conversely, excessive contamination can reduce the amount of water available for desired uses. For these reasons, we strongly urge those states that do not have a withdrawal permit system to consider, at least for threatened groundwater areas, the adoption of such a system.

We also recommend that states find ways to coordinate groundwater quality concerns directly with quantity management. Some types of aquifer classification systems help provide this coordination by basing the amount of protection given to an aquifer on the types of uses that may be made of it. On the quantity side, we think that the permit process for groundwater withdrawals should consider how the quality of available water will be affected if the permit is granted. For example, new pumping should not lead to further spread of existing contamination or heighten the danger of saline intrustion from the ocean or from another aquifer.

Conjunctive Management of Ground and Surface Water. We also recommend that groundwater management programs be closely coordinated with all programs for managing surface-water quantity and quality. Surface waters—while they are in a natural stream channel or after they are withdrawn for off-stream use—are a major source of recharge for many groundwater aquifers. Many water demands can be satisfied from either surface sources or groundwater. And groundwater is the major source of base flow in many of the nation's streams.

Coordination and integration can be achieved in varied ways. Some states such as New Jersey have extended programs for permitting discharges to surface waters to include discharges to groundwater. In New Mexico, new applicants to pump groundwater must show that their pumping will not harm holders of either surface or groundwater rights. The state can take action against groundwater withdrawals that cause a depletion of stream flow.

Coordination with Other Programs. Finally, those programs already controlling specific types of contamination sources need to be coordinated with the groundwater management program. Environmental protection programs controlling the disposal of hazardous wastes, the use of pesticides, the operation of sewage treatment facilities, air pollution, and radioactive wastes are only the most obvious of these. Groundwater protection efforts would also benefit from coordination with programs for inspecting mines, issuing permits for septic tanks, siting energy facilities, promoting industrial development, and a host of other governmental activities that affect the use of land and the exploitation of the nation's natural resources.

At the state and local level, the coordination mechanisms adopted should be left to the governor and state legislators. At the federal level, any groundwater statute should establish coordination mechanisms within EPA and between EPA and the other agencies. At all levels of government, the means used to integrate programs are less important than the fact that integration and coordination take place.

Ensuring Program Implementation

In the event that any level of government fails to exercise its responsibilities for groundwater management, some inducements to action are appropriate. One of the most effective stimulants is the citizen lawsuit, and we recommend that such suits be authorized in both the state and federal groundwater legislation. Citizens and interested groups should be empowered to challenge any failure by any government to perform a nondiscretionary duty, including the failure to meet any statutory deadline for adopting a comprehensive groundwater program.

Moreover, certain grants relating to environmental remediation should be withheld from those states that fail to enact a groundwater management program. For example, several federal programs—such as the Superfund hazardous waste program and projects of the Bureau of Reclamation, Army Corps of Engineers, and Department of Agriculture—are used to clean up contaminated groundwater or increase groundwater supplies. If a state is unwilling to adopt a comprehensive groundwater program, expenditures for these other efforts may be futile. Therefore, we recommend that the federal groundwater statute require that the appropriate federal agencies withhold funds for these groundwater-related activities from any state unwilling to adopt and implement an adequate groundwater program. In addition, EPA should be required to withhold implementation grants for groundwater protection if EPA or program review committee oversight reveals serious deficiencies in the state program.

State programs, in turn, should require adequate assurances that local governments carry out their state-assigned responsibilities. To meet this requirement, state programs should include a provision that allows the state to implement local responsibilities, including adequate surface-use restrictions, if the local governments do not. For example, New Jersey's law to protect the Pinelands and their vulnerable groundwater resources allows the state to develop and carry out land-use plans for Pinelands towns that fail to act.

Action Now

The previous sections set forth an imposing agenda, but not in comparison to the significance of the resource at stake. The gamut of human activities has been shown to affect groundwater in so many unexpected ways that the nation must err, if at all, on the side of protection. The vast and irreplaceable groundwater resource must now be given the aggressive protection required to safeguard it for future generations and to assure that, operating with incomplete knowledge, human actions do not taint it irreversibly. Through a wise, balanced, and forceful strategy of preventing contamination, the country can meet the problem effectively before drastic measures become unavoidable.

The quintessentially local character of groundwater—its occurrence, use, and contamination—dictates that the states, not the federal government, bear primary responsibility for groundwater protection. States that have not already done so should begin immediately to design the type of comprehensive protection and management schemes called for in this document and to enact the legislation and establish the institutional capacity to implement the programs they develop. This will assure timely, effective action to protect the health of their citizens and the integrity of this vital resource.

In dealing with a problem as complicated as protecting groundwater resources, the federal government must assume a major role, providing the necessary impetus to ensure that states carry out their responsibilities and assisting them in their efforts. But the federal role should differ in one key respect from what it has been in most of the environmental laws of the past 15 years. The federal government should require states to act but leave them to define the details of their actions. States need not and should not wait until the federal government takes action before initiating their programs.

Congress should enact groundwater protection legislation that sets a clear national goal and sets the states solidly on the path to achieving that goal. Such legislation is essential to bring order out of the present patchwork of federal statutes affecting groundwater quality. To induce states to act quickly and decisively, the legislation should authorize grants to the states for designing and implementing comprehensive groundwater management programs.

While Congress is enacting the necessary legislative authority, the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS) should be conducting the studies and analyses required to speed groundwater protection programs on their way once they are adopted. EPA should begin to assess the relative risks being created by inadequately controlled sources and to identify techniques for regulating them.

At the same time, EPA should begin collecting and analyzing the information necessary to develop guidelines for establishment of ambient groundwater quality standards; continue its efforts to coordinate and integrate existing federal programs related to groundwater; and expand its efforts to provide technical assistance to states. The USGS should accelerate its efforts to assist states to define their groundwater resources and establish monitoring programs to measure changes in groundwater quality.

A new environmental partnership is essential to groundwater protection, and the full participation of local governments is critical to partnership success. Local governments have the primary duty to secure potable groundwater supplies. They therefore must ensure that potential sources of contamination under their jurisdiction—such as landfills, sewage sludge, and septic tanks—do not threaten those supplies. State and federal actions must not undercut the initiatives of local governments that move aggressively to safeguard their aquifers.

The private sector must begin to demonstrate the enterprise of which it is capable. It must develop processes, products, and materials that will prevent additional groundwater problems and help the nation deal with those problems that already exist. The more such voluntary efforts are successful, the less the private sector need fear the burdens of regulation, and the faster the nation will begin to get its groundwater problems under control. All levels of government must join the private sector in the search for alternative techniques of source reduction and recycling to minimize the total amount of waste disposed of on land.

Finally, public interest groups must continue their traditional role in heightening awareness of the potential threats to groundwater. Public education can help build the strong political base at the state and local levels that will be essential to the adoption and implementation of the comprehensive measures necessary to protect groundwater effectively.

Everyone has a role, and everyone has a job. The nation cannot afford to delay while each party waits for another to act. The time for action is now.

GROUND WATER CONTAMINATION AND PROTECTION

THURSDAY, DECEMBER 12, 1985

U.S. Senate,
Committee on Environment and Public Works,
Subcommittee on Toxic Substances
and Environmental Oversight,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:05 a.m., in room SD-406, Dirksen Senate Office Building, Hon. Dave Durenberger (chairman of the subcommittee) presiding.

Present: Senators Durenberger, Abdnor, Humphrey, and Baucus.

OPENING STATEMENT OF HON. DAVE DURENBERGER, U.S. SENATOR FROM THE STATE OF MINNESOTA

Senator **Durenberger**. The hearing will come to order.

Today we are holding our sixth and final oversight hearing on the subject of ground water contamination. When we begin again next year, we will be holding legislative hearings with the hope that we can move a ground water protection bill to the floor during the 2d session of the 99th Congress.

This is actually the second part of a hearing that was originally scheduled for November 15. To assure that all of our witnesses could appear, we have rearranged the schedule somewhat and we wish to thank those witnesses who kept their personal calendars flexible so that this would be possible.

The principal subject matter of today's hearing—nitrate contamination of ground water supplies—illustrates in many ways the difficulty of the ground water problems.

The Environmental Protection Agency has set a maximum contaminant level for nitrates. This standard was set to prevent a condition called "blue baby disease." Nitrates in the stomachs of infants and newborns can be converted to nitrites by bacteria. In that form, the nitrogen is picked up by the blood cells and prevents adequate uptake of oxygen. The result, blue baby disease, is treatable, but it is also preventable and that is why we have a Federal health standard.

But the standard is being exceeded in many parts of the Nation, and particularly this is true in the upper Midwest. As many as 6 percent of the wells in the rural areas of the North Central United States exceed the EPA standard. Although the water supplies of many towns, including the city of Des Moines, IA, have also been found to exceed the standard, the principal problem is with private drinking water wells. These wells, which supply about 20 million American households with their drinking water, are typically untested and untreated.

Nitrate contamination of ground water supplies can come from several sources. Septic tanks, cesspools, and animal feedlots are high on the list of potential concerns. But it is not just a waste disposal problem. Another large factor in the nitrate problem is something that we do intentionally, and that is applying chemical fertilizers to our crops and our gardens to improve yield.

When we get to our agricultural panel later this morning, I think that we will find general agreement that something should be done to improve the efficiency of fertilizer uses. But we will also find that in terms of technology and human institutions, it is a very difficult problem to solve.

Before we get to that panel, we have two other witnesses, including the Senator from Tennessee, who has a deep interest in this problem.

Senator Mitchell has submitted a statement and, without objection, we will make it part of the record of these hearings.

[Senator Mitchell's statement follows:]

STATEMENT OF HON. GEORGE J. MITCHELL, U.S. SENATOR FROM THE STATE OF MAINE

Mr. Chairman, I would like to welcome the witnesses for today's hearing on the important subject of ground water protection.

And, I would like to extend a special welcome to our colleague, Senator Gore. I understand that the Senator recently chaired a hearing on the subject of ground water pollution in his home State of Tennessee. I look forward to learning the results of that hearing and Senator Gore's views on this important issue.

Other witnesses at today's hearing will focus on the problem of pollution of ground water from fertilizers. An important aspect of this problem is nitrate contamination of ground water used for drinking water. As we will hear today, high levels of nitrates are found in some 2 to 3 percent of households throughout the Nation.

Homes located in rural areas, near agricultural areas, and over shallow ground water systems, are at greater risk of nitrate contamination. Studies in major farming States indicate that up to 20 to 30 percent of wells exceed Federal nitrate standards. Infants are especially susceptible to high nitrate levels, suffering a reduced level of oxygen in blood cells, often referred to as the "blue baby disease."

Nitrate contamination of ground water is often thought to be a problem confined to the major agricultural areas of the Midwest. There is new evidence, however, of the seriousness of this problem in my home State of Maine. A recent study by the Maine Geological Survey identified unexpectedly high levels of nitrates in ground water. Of some 40 test wells, nitrate levels exceeded the Federal standard in twelve wells.

Mr. Chairman, the State of Maine has just completed this study and printed copies are not yet available. I request that the study, which will be available shortly, be included in the record of this hearing.

Thank you, Mr. Chairman.

Senator **DURENBERGER**. Our first witness this morning will be Senator Gore of Tennessee, who was here on Tuesday, when we had our hearing on climate destruction and the warming of the atmosphere. I believe, Al, that you will be describing, at least in part of your statement, a conference held in Nashville sponsored by the Environmental and Energy Study Institute that dealt specifically with ground water contamination problems. So we welcome you.

STATEMENT OF HON. ALBERT GORE, JR., U.S. SENATOR FROM THE STATE OF TENNESSEE

Senator GORE. Thank you very much, Mr. Chairman.

Thank you again for your courtesy. I don't want to give you the impression that I am going to be a regular witness here. As a colleague who is not a member of your committee, I wish that I could be here all the time, but I am not going to abuse the courtesy of the committee. It is coincidental that I came twice this week, but I do appreciate your courtesy very much.

I had intended to present this statement at an earlier hearing. I am glad to have the chance to do so briefly here today. I will not belabor it.

I was very active in dealing with this problem in the other body. As you mentioned, this fall, I chaired a regional meeting of the Energy and Environment Study Institute in Nashville to address the problem of ground water contamination. I want to share with the committee briefly the results of that regional conference and tell you that I am very eager to help in efforts that are underway behind your leadership, Mr. Chairman, to address this problem on a national basis.

All of our colleagues on both sides of the aisle are deeply appreciative of the interest that you have expressed in this problem. It is a very, very great and grave problem, and it must be addressed in a bipartisan way. As someone who is not a member of the committee, I just want you to know that there are a lot of people in the Senate who are interested in helping you when you bring a product out of this subcommittee to the floor.

That enthusiasm and eagerness reflect the basic desire of the American people, our constituents, to see this problem addressed.

Ground water is arguably the single most important natural resource on this planet. Without an adequate supply, we simply could not survive. That is obvious. Ground water constitutes 96 percent of all the fresh water in the United States. More than half of our population relies on ground water for its drinking water supplies. Approximately 95 percent of rural households nationwide depend on ground water for drinking water.

Tennesseans are no exception. Fifty-one percent of Tennesseans rely on ground water for their drinking water. Our rural population is almost exclusively dependent on it. In parts of the State, particularly in the western part of the State, all public water supplies come from ground water. Indeed, Memphis, the largest city in our State, is totally dependent on ground water for its drinking water supplies. Yet, despite its obviously great importance to us, our Nation has until very recently virtually ignored the problem facing our ground water supplies.

Unlike other forms of pollution that are easily seen or smelled, ground water contamination is an invisible enemy, and is subject to the old cliche, "out of sight, out of mind," which all too accurately describes our reaction to this serious threat.

Reckless environmental practices in the past, including hazardous waste disposal and other activities, have caused some ground water supplies across the country to become irrevocably contaminated. In fact, in Hardeman County, TN, the indiscriminate dumping of toxic wastes into a landfill has resulted in a 1,000-acre plume of contaminated ground water which threatened the drinking water supplies of the people in that rural county. This water can never be cleaned up. The contamination is actually growing slowly, but steadily.

OTA estimated last year that over 200 contaminants can currently be found in our ground water, including 150 organic chemicals, 40 inorganic chemicals, 20 radionuclides, and various micro-organisms. Of these substances, at least 13 are known or suspected carcinogens.

The EPA has estimated that two-thirds of all rural households are using water contaminated with at least one of these contaminants. Nearly one-fourth of all municipal drinking water systems show some contamination. Nationally, it is estimated that 1 to 2 percent of the total ground water supply is contaminated to some extent. A report released by the Department of Interior this past spring indicated that contamination is increasing in some areas.

As if these figures were not disturbing enough, an internal EPA report made public last October concluded that many monitoring programs of ground water across the country are so poor that we really don't know how bad the problem is. It could be much worse than we already know.

The saddest part is that that contamination is not inevitable. Indeed, it is greatly preventable. The key is to know what to do, and then to do it. Once contaminated, ground water cannot be cleaned up, at least not without tremendous expense. So our efforts must obviously be focused on prevention and on developing programs to keep our ground water from being polluted in the first place. This was the focus of the regional conference in Nashville in October. It focused on ground water protection policies for Tennessee and the Tennessee Valley multistate region.

The conference was sponsored by the Environmental and Energy Study Institute and the Tennessee Valley Authority. The participants in the conference included State and local officials, representatives of business, scientists, and members of the general public. A consensus was quickly reached at the conference that in spite of its localized aspects, ground water contamination is a national problem that must be dealt with at the national level.

We looked at the regional characteristics of the problem in the Tennessee Valley, and there are some special problems there. But it must be addressed on a national basis, and this was one of our principal conclusions. A second consensus that was also quickly reached was that the leadership at the national level adequate to the task has not yet congealed and that the kind of effort begun in this subcommittee is greatly needed. Many of the participants mentioned, with hope and anticipation, the work of this subcommittee, and shared optimism that in the second session of this Congress, we may really be able to get the ball rolling.

But as of now, of course, as you well know, Mr. Chairman, our Nation has not yet developed an aggressive and workable ground water protection strategy. There are currently 16 Federal laws that have some impact on ground water protection, but none of them has ground water protection as its primary objective. Some of them are actually inconsistent with the others. Instead of a viable program, we now have a hodgepodge of statutes, a patchwork system that fails to protect our precious ground water supplies.

Last year, EPA issued its long-awaited ground water protection strategy, but in reality it is more like a public relations strategy. There is a lot of rhetoric, but not much substance. There are no new initiatives, no new programs, no new funding, and most importantly no new standards for ground water quality to help guide the efforts of the States and local communities like those that were represented in this conference in October.

My own State of Tennessee is far ahead of many other States, in my opinion, in its effort to develop a ground water protection program. Earlier this year, Tennessee created an office of ground water protection. Recently, it issued a draft ground water protection strategy. Nevertheless, they, and others at the conference, were in agreement that in the absence of strong leadership from the Federal Government, even States that make a strong commitment and dedicate resources and fashion new and effective policies have an uphill battle and little hope of real success unless we have strong leadership from the Federal Government.

In addition to a lack of technical and financial aid, much of the problem is due quite simply to the absence of any Federal standards on ground water contamination. Tennessee borders on seven States, more than any other State in the Union. Since ground water doesn't stop at the State line and say, we can't go beyond this imaginary boundary, it obviously is a problem that is beyond the ability of any State to deal with on its own.

We could have the strongest ground water protection program in the whole country, but it would still be only partially successful because we have no control over the quality of water that flows into the State and under the State from other sources.

The ultimate responsibility for protecting our ground water resources must inevitably reside with the States, but it is the job of the Federal Government to find a way to encourage cooperation between the States, to provide for regional differences, give technical and financial assistance where needed and, most importantly, to establish Federal ground water standards to insure uniform protection of the public health. Otherwise, as the head of our State's ground water program, appointed by Governor Alexander, said, the only solution would be for the State to erect barriers at its borders to prevent contaminated ground water from another State from flowing into it. This, of course, is neither possible nor desirable. It is just a rhetorical way to illustrate the need for Federal standards.

It is imperative that the Congress act soon to develop workable ground water protection legislation before the problem worsens and before serious conflicts between the States develop. Fortunately, a lot of good work is beginning to be done to correct this situation. As I indicated earlier, the hearings of this subcommittee have helped to focus the debate. Thanks to the efforts of you, Mr. Chairman, and many members of this committee, and members in the other body, the broad outlines of the solution are now beginning to be apparent.

It is a big task, a big challenge, but we are on the way to meeting that challenge. Again, I stand ready and willing to assist you and other members of the committee as this effort picks up speed in the coming year.

Again, thank you for your courtesy in letting me come twice in one week.

Senator **Durenberger**. Al, thank you very much for your insight. After the statement and the time that you put in on the warming issue on Tuesday, and the comprehensive analysis of ground water, I can understand why we would want you to come back more often and help us in this effort. I personally do, and I compliment you on your statement.

Are you chair or vice chair of the study conference.

Senator **Gore**. Vice chair.

Senator **Durenberger**. Are there going to be more hearings and, if so, could you give us an idea of where it might lead the conference?

Senator **Gore**. There have been others already. There will be one in Kansas and in Denver in January. There have been ones already in Florida, Ohio, Tennessee, and one in California also.

We are going to put together the results of all the regional conferences, and we will be presenting an overview of the problem as a result of those conferences around the country.

Senator **Durenberger**. If we were to put in our new nonpartisan, bipartisan, antipartisan, ground water protection bill at the end of January, or at least early in the next half of this session, and held some hearings toward trying to move something in the spring, does that sort of conform with the schedule that the conference is on, too, so that we can get some input from these various conferences?

Senator **Gore**. Yes, it does. We are more than interested in helping. As you know, we have many members from both bodies and both parties. It would be a good schedule. In general, the earlier the better, as you well know, because of the pressures to adjourn early next year. I would be very comfortable with a work schedule like that outlined by this committee. I really think that it is achievable.

Senator **Durenberger**. I would just point out why it is a valuable experience for us to share, that is the series of conferences.

Not everything is bad that EPA has done, I don't think. It may be in part public relations, but there also might be a framework there. One of the areas that we have expressed some concern with up here is the classification scheme. Do you recall whether that issue came up in the Nashville conference at all, and whether there was any reaction to that?

Senator **Gore**. It did come up. EPA has articulated a three-part classification scheme. The State of Tennessee has proposed a two-part classification scheme. Concern was expressed by several witnesses that a classification for ground water is unworkable and possibly dangerous. First, many aquifers are interconnected, and water from a lower classification, less protected system could flow into another system that is supposed to be kept pure. Second, a classification system is tantamount to writing off certain ground water supplies. The whole purpose of a classification system is to designate some ground water as "available for contamination." This raises serious questions. There were other concerns as well, but these were the two principal ones. I would encourage you, Mr.

Chairman, to take a good, hard look at the wisdom of a classification system.

Senator DURENBERGER. Thank you very much. I appreciate your testimony.

Senator GORE. Thank you.

Senator DURENBERGER. Our next witness this morning is Jane Bloom from the Natural Resources Defense Council of New York City, who is here with us to speak about underground injection, a subject on which this subcommittee has held several hours of hearings in preparation for amendments to the Safe Drinking Water Act. Those amendments are now pending in the House-Senate conference.

Jane, your full statement will be made a part of the record. We appreciate your being here, and you may proceed.

STATEMENT OF JANE BLOOM, NATURAL RESOURCES DEFENSE COUNCIL

Ms. BLOOM. Thank you, Mr. Chairman.

On behalf of the Natural Resource Defense Council [NRDC], which is a national nonprofit environmental organization, with over 50,000 members and contributors, I want to thank you for inviting us to testify and present our views on ground water protection, and on sources of contamination that may threaten underground sources of drinking water.

NRDC has long sought improved protection for ground water, and has worked to strengthen EPA regulatory programs established under the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Clean Water Act, and other laws which affect the quality of present and future drinking water supplies.

NRDC applauds the committee's interest in developing legislation for ground water preservation, and we believe more must be done now to address the myriad sources of ground water contamination that are not adequately being covered by existing laws.

My testimony presents NRDC's concerns about one of these sources, which is the subsurface disposal method known as underground injection.

NRDC believes that the intensive and increasing use of underground injection for waste disposal may pose serious threats to drinking water sources unless greater restrictions are imposed on this disposal practice. There are an estimated 221,000 injection wells in the United States today. This is probably an underestimate for reasons that I will discuss a little bit later on.

Injection through at least one of the five classes of wells identified by the underground injection control regulations takes place in nearly every State. Indeed for certain types of wastes, underground injection is the predominant mode of disposal. According to EPA, almost 60 percent, or over 11 billion gallons annually, of all hazardous wastes disposed of under RCRA are injected into 195 class I injection wells, or deep wells, which are wells that inject wastes into zones below aquifers that meet the Safe Drinking Water Act's definition of underground sources of drinking water.

There are also an estimated 525 billion gallons of brines that are used for enhanced recovery of petroleum or are removed during oil and gas operations that are also injected each year into approximately 150,000 so-called class II injection wells.

Class III injection wells are used in conjunction with specific mineral extraction activities, including solution mining for uranium and other ores. As of August 1983, there were an estimated 25,000 class III injection wells.

The last category, which I am going to discuss, class V, was estimated to contain about 48,000 injection wells, but this is probably an underestimate because many States have not finished inventorying and assessing these. This is the "grab-bag" category that EPA defines as all injection wells that don't fall within classes I through IV, and they include wells disposing radioactive waste, storm and agricultural drainage wastes, and multiuse cesspool wastes. It is a very large category, with the potential to contaminate ground water.

There have been numerous incidents of environmental damage or ground water contamination due to injection. For example, over half of the oil and gas producing States, that is 17 out of 32, have reported cases of ground water contamination from brines. There have also been many cases of contamination due to injection of hazardous wastes. I would like to describe a couple of those briefly to illustrate what we think may be the extent of the problem.

A rather well-known case occurred in Presque Isle State Park, and it is believed to have occurred as a result of injection of 1.1 billion gallons of papermaking waste 1,500 feet below the surface by the Hammermill Paper Co., which is located in Erie, PA. Seven years after injection had ceased, which was in 1979, wastes were discovered spurting onto the surface through an abandoned oil well 4.2 miles from the Hammermill injection wells and into Presque Isle State Park.

USGS and EPA are greatly concerned that injected wastes may be rising into Lake Erie which serves as a drinking water source for residents of Erie, PA, or through the countless abandoned wells that penetrate the geologic formation into which the wastes were injected.

Indeed, because the formation in which wastes were injected runs under Lake Erie to Michigan and to southern Canada, USGS fears that ground water contamination from the Hammermill wells could be manifested far beyond the Pennsylvania border. EPA listed this site on the Superfund national priorities list in 1982.

A much more recent incident, that is believed to be a potential result of underground injection and is now being investigated, was discovered last month at Sarnia in Ontario, Canada. Large globules of toxic chemicals, including dioxins, hexachlorobenzene, and hexachlorobutadiene, were found floating in the St. Clair River, which crosses the United States and the Canadian border, and supplies water to both Canadian and Michigan residents. According to newspaper reports which we have submitted for the record, Environment-Canada believes that part of the contamination may have seeped up from cracks in the river bottom and may be emanating from 16 abandoned injection wells used to dispose of hazardous wastes.

I also have a situation report, which I have not submitted for the record, but I will be glad to do so, which was jointly issued by Environment-Canada and the Ontario Ministry of Environment, which describes some of the subjects of investigation with respect to this problem.

Senator DURENBERGER. Are you getting near the end of your testimony?

Ms. BLOOM. I will try to move along.

Senator DURENBERGER. Thank you.

Ms. BLOOM. Our concern about underground injection is not only that the practice may threaten ground water, but also that the regulations that EPA has promulgated are remarkably lax. Our testimony describes several different problems that we have with the regulations, which include the lack of any regulatory requirements for class V wells, other than that they be inventoried and assessed; the lesser stringency of regulation for hazardous wastes deep wells, which are class I wells, than the requirements under RCRA for all other hazardous wastes disposal methods; and also, and perhaps most importantly from this committee's point of view, a provision of the regulations which allows EPA to exempt from regulatory protection aquifers that meet the definition of underground sources of drinking water.

Once exempted, an aquifer may be used for disposal of various wastes by underground injection. All told, 59 aquifers, or their portions, have been granted exemptions by EPA or delegated States. In our view, the aquifer exemption provision amounts to a license to write off valuable future drinking water resources in violation of the Safe Drinking Water Act's underlying purpose, which is to prevent endangerment of drinking water supplies.

My written testimony illustrates why we believe that this exemption ought to be repealed, and we strongly recommend that the committee do so in any forthcoming legislative action on ground water protection.

In addition, we recommend that the committee take a pretty hard look at underground injection generally, and the threat that it may pose to ground water, particularly the failure to regulate class V wells and the lesser stringency of controls on class I underground injection wells when compared to the RCRA requirements for other land disposal of hazardous wastes.

That concludes my testimony. I will be glad to answer any questions you may have.

Senator DURENBERGER. Let's start with class V wells, and work our way back to hazardous wastes.

It is my impression of the classified well categories that class V is just a catchall classification. Any hole in the ground that is deeper than it is wide, which is not a class I, II, III, or IV is a class V well. Is that an accurate description of class V?

Ms. BLOOM. I believe so. It includes such wells as radioactive waste disposal into deep wells, and drainage wells for storm runoff and, as you say, everything else that is not a class I through V. It is the grab-bag, as we see it.

Senator DURENBERGER. Can you briefly describe them in terms of what goes into them, how deep are they, how near to ground water that provides drinking water. Do we actually know much about those 48,000 wells?

Ms. BLOOM. That is the problem. I would like to be able to provide you with that information, but actually it is within EPA's possession to the extent that it does exist. The problem is that many of these wells have not even been inventoried because EPA's requirements state that within a year of a State having an approved UIC program, it is then to inventory the wells, which means to simply locate them and state what they do in a very general way.

Senator DURENBERGER. In the 11 years since we have had the Safe Drinking Water Act, we still don't know anything about them.

Ms. BLOOM. We still know very little. We know remarkably little. I would also recommend that you pose this question to EPA because the agency is now beginning to collect this information from the States that have been inventorying, but it is incomplete and it needs to be looked into.

Senator DURENBERGER. Let me ask you about class IV wells, wells designed to dispose of hazardous wastes into or above a drinking water supply. As I understand it, they have been banned by both regulation and by law, but it seems to me that the only difference between the class IV and class V is that IV is known to take hazardous wastes.

My question is: How do the regulations define hazardous wastes? Do they depend on the RCRA definition of hazardous wastes, and is that an adequate definition?

Ms. BLOOM. They do depend on the RCRA definition of hazardous wastes. I think your point is a very good one. The wastes that are going into class V wells, especially to the extent that they are radioactive wastes, are probably equally if not more hazardous than the stuff that was banned from injection into USDW's by the class IV ban.

One other point I would like to make is that the aquifer exemption also relates to this very closely because even though injection of hazardous wastes as defined by RCRA is banned through class IV wells directly into an underground source of drinking water, if an aquifer is exempted for the purposes of hazardous waste disposal, hazardous waste can be deposited directly in the aquifer. So this is still a loophole which remains.

Senator DURENBERGER. Let me ask you now about class II wells, the wells for reinjection of brine that is produced by oil and gas wells.

It is my impression that practices for disposing of brine have changed in the past few years. At one time, most States allowed brine to be pumped into unlined evaporation pits from which they could readily leach into the ground, but now most of the States are requiring some kind of protective disposal practices.

Do you know which States still allow disposal in unlined evaporation pits?

Ms. BLOOM. No, I don't, offhand. Most of our energy has been placed in the last few years in trying to get control of hazardous wastes and of class V's, which we think may be the most threatening categories. I will try to find out that information.

Senator DURENBERGER. Do you have a general idea of how much of the contamination from brine might come from unlined and unprotected evaporation pits, and how much might come from injection wells that are regulated as class II?

Ms. BLOOM. My understanding is that most of the injection wells are subject to technical standards, and are not unlined. I think you are thinking about what they call annular injection, perhaps, and that is a relatively minor practice in the whole scheme of things. That is my understanding, but I am not an expert on class II wells.

Senator DURENBERGER. Can you cite any specific cases of contamination incidents from class II regulated wells that we ought to consider?

Ms. BLOOM. There have been quite a number of them in Texas and Louisiana that were mentioned in the cited document reference in our testimony.

Senator DURENBERGER. Do those documents also include some recommendations on how the regulation of oil and gas brine injection wells ought to be modified?

Ms. BLOOM. Our testimony does not, but I think there are recommendations in those documents.

Senator DURENBERGER. In the context of Superfund, we sometimes talk of imposing a waste-end tax, and when we do there is the question that always arises as to how we should treat wastes disposed of by injection in comparison to wastes that go into a landfill.

Do you think that there should be a waste-end tax advantage for injected wastes as opposed to land disposed wastes? Should the tax, for example, be lower for injection?

Ms. BLOOM. We think that at the present time there is really no evidence that distinguishes risks posed by underground injection from all other land disposal practices. Therefore, no break should be given to this particular practice. We have not been supportive of the waste-end tax concept for superfund generally because it is not a very reliable way of raising funds. To the extent that it is employed in the Superfund legislation, we would like to see it be a flat tax, which taxes essentially at the same rate all forms of land disposal, but that is not the current situation in the proposals on the House side, as far as I understand.

Senator DURENBERGER. You have stated that 59 aquifer exemptions have been granted under the UIC program. Do you know how many of those exemptions granted for class II or III operations were granted solely on the basis of being commercially producible, or if other quality or economic exemption conditions also applied?

Ms. BLOOM. I have tried to find out the answer to that question, actually, because it has been of concern to me. I have been told that roughly 90 percent of all of the exemptions that were granted, were granted under that provision, but not necessarily under the portion of it which is for commercially producible. There is another part of it that says, "which is now producing energy."

Senator DURENBERGER. Is there some way that we can facilitate getting that information?

Ms. BLOOM. I think in fact you could. One of the reasons that EPA was a little reluctant to talk with us is because we are involved in litigation challenging a class III exemption which was granted in Nebraska. They are under instructions not to talk to us about anything having to do with class III. So I think that you could help.

Senator **Durenberger**. Do you have any information on what EPA or the States are requiring in terms of ground water quality restoration in those cases where mining activity has been allowed?

Ms. **Bloom**. I am not familiar with that, I am sorry.

Senator **Durenberger**. Your testimony includes newspaper accounts of the contamination incident which has recently come to light in Canada. It appears that underground injection practices of the Dow Chemical Co. have caused releases to the bed of the St. Clair River.

Are you familiar with the case, or with Canadian regulation of underground injection, and could you venture an opinion on whether Canadian law and regulation is more or less protective than United States law in this regard, or in some different way? Will our UIC regulations prevent this kind of contamination that occurred up in Canada?

Ms. **Bloom**. Answering the first part of the question first. Because of leakage from those 16 wells that I mentioned—which incidentially are not all Dow Chemical wells, in fact, there are a variety of chemical companies which, in the past, used deep well facilities in Sarnia which is known as the chemical valley of Canada—wastes began to come up in the surrounding area. They are believed to have come up through various abandoned wells.

In 1976, after a few of these incidents had occurred, where waste came up in Sarnia behind the theatre, and then in Port Huron in Michigan, and they were believed to emanate from these 16 wells, Canada decided that it would ban pressurized hazardous waste injection, and that is not banned in this country. It is, in fact, an authorized practice according to the class I UIC regulations.

Canada's experience, I guess, was so bad that they decided that they wanted to prohibit the practice altogether, and we haven't done that.

Senator **Durenberger**. Let me finish with a migration question. This relates to ground water monitoring, and we are getting some conflicting testimony on ground water monitoring in connection with the UIC.

Are you an advocate of ground water monitoring at every UIC site, regardless of the geology involved. Some people have told us that it is kind of a dangerous position to take because the drilling that is involved in monitoring, obviously, might develop a pathway for migration into other ground water supplies.

Ms. **Bloom**. There is one way to answer that question and it is to say that, to the extent that it is unmonitorable technology in certain cases and it does present risks to ground water, we would rather see that those sites not be used.

We would like to see that ground water be monitored, and also that the injection zone be monitored. If the agency is going to argue that it can set appropriate technical standards for the wells themselves, and that that is safe, that you can inject wastes safely that way, then they can't at the same time argue that the monitoring wells will open conduits that can't be plugged and that are going to result in the release of contaminants. They really can't have it both ways. Either you can monitor with technology and conduct it safely, or you can't. We believe that it can be monitored and should be in many cases.

Senator **Durenberger**. Thank you, Jane, very much. We appreciate your testimony.

Ms. **Bloom**. Thank you, Mr. Chairman.

Senator **Durenberger**. We are now combining our two panels because Bill Larson from the University of Minnesota's Department of Soil Sciences has pneumonia in the middle of 24 inches of snow and couldn't come.

[Mr. Larsen's statement appears at p. 342.]

I think that we will be able to address the subject more than adequately with the three people on the panel. First, Al Giese, who is the vice president of Land O'Lakes Co., here to speak for the Fertilizer Institute; Dr. George Hallberg, who is the chief hydrologist for the Iowa Geological Survey, who is engaged in regional research in the Big Spring Basin in northeastern Iowa; and Dr. Thomas Army, who is with the Agricultural Research Service, who is here to tell us what the Federal Government can do to solve the ground water problems for the Nation. At the very least, Dr. Army is making one of the best efforts to understand the problem so that a solution can be attempted by those of us who are representing the people of the nation in its legislative body.

Gentlemen, we are ready for your statements. I think you understand that we are trying to keep them within 5 minutes, if possible, so that we can open up to discussion. We will begin with the gentleman from Land O'Lakes.

STATEMENT OF AL GIESE, VICE PRESIDENT, LAND O'LAKES, ON BEHALF OF THE FERTILIZER INSTITUTE ACCOMPANIED BY BILL WHITE, FERTILIZER INSTITUTE

Mr. **Giese**. Thank you, Mr. Chairman.

My name is Al Giese, and I am vice president of the Agronomy Division of Land O'Lakes, Inc., in Minneapolis, MN. I am here today on behalf of the Fertilizer Institute, for which I am chairman of the Water Quality Work Group. I am accompanied by Bill White of the Fertilizer institute, sitting on my left.

I would ask that my full written statement be entered into the record, along with the institute's educational brochure entitled, "Clean Water" (see p. 262), and two authoritative references, a book entitled, "Nitrogen Crop Production" (retained in committee files), and the perceivings of an institute sponsored symposium on plant nutrient use and the environment.

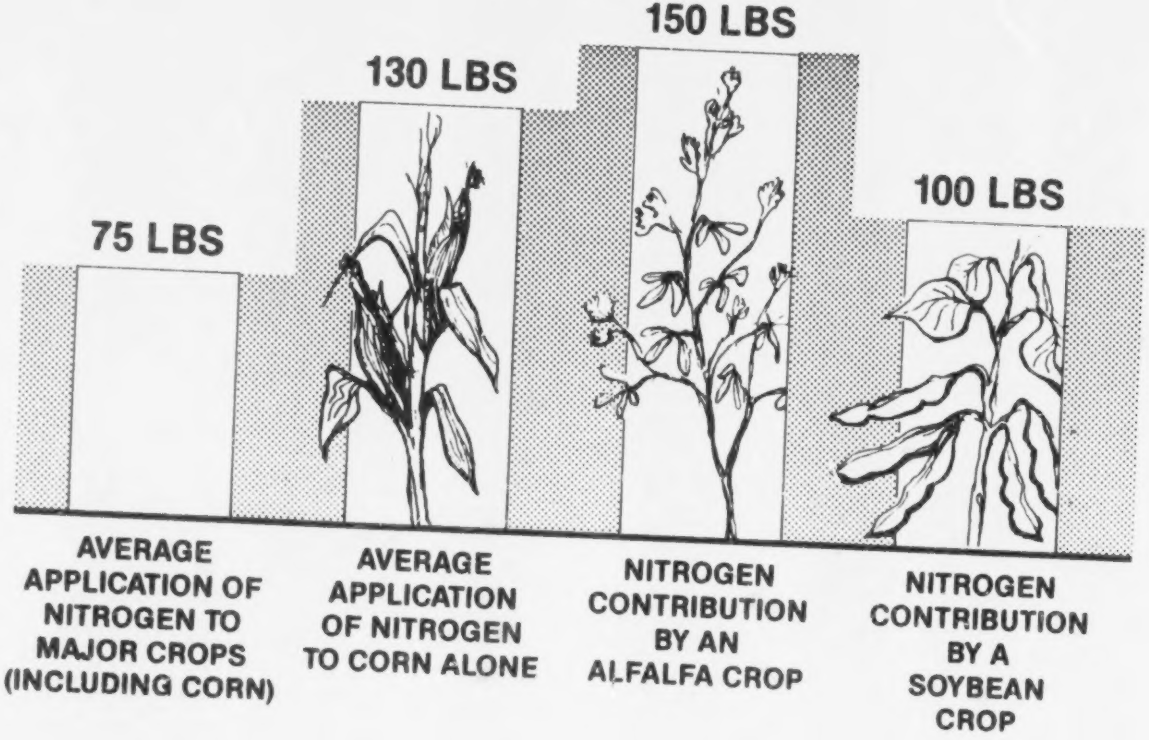
The fertilizer industry shares your concerns about ground water quality, and we commend you for holding these hearings. Obviously, my appearance here today is aimed at focusing on concerns related to nutrients in ground water.

As you know, American agriculture is very dependent on the use of fertilizers for maintaining soil productivity. USDA estimates that fertilizer use accounts for about one-third of our total crop production. Of the essential nutrients supplied in fertilizers, nitrogen is the only one that is sufficiently soluble to be mobile in the ground water.

Nitrogen for food production comes from a number of sources including commercial fertilizers. As you can see by the illustration entitled, "Nitrogen Supplies by Commercial Fertilizers Versus Nitrogen Supplies From Crops," for instance, an alfalfa crop can add up to 150 pounds of nitrogen to the soil per acre per year having drawn that nutrient from the air we breathe. Soybeans, in a like manner, can add up to 100 pounds of nitrogen per acre to the soil. Yet, according to USDA, in 1984, the average application rate of nitrogen in commercial fertilizers was 75 pounds of nitrogen per acre for major crops.

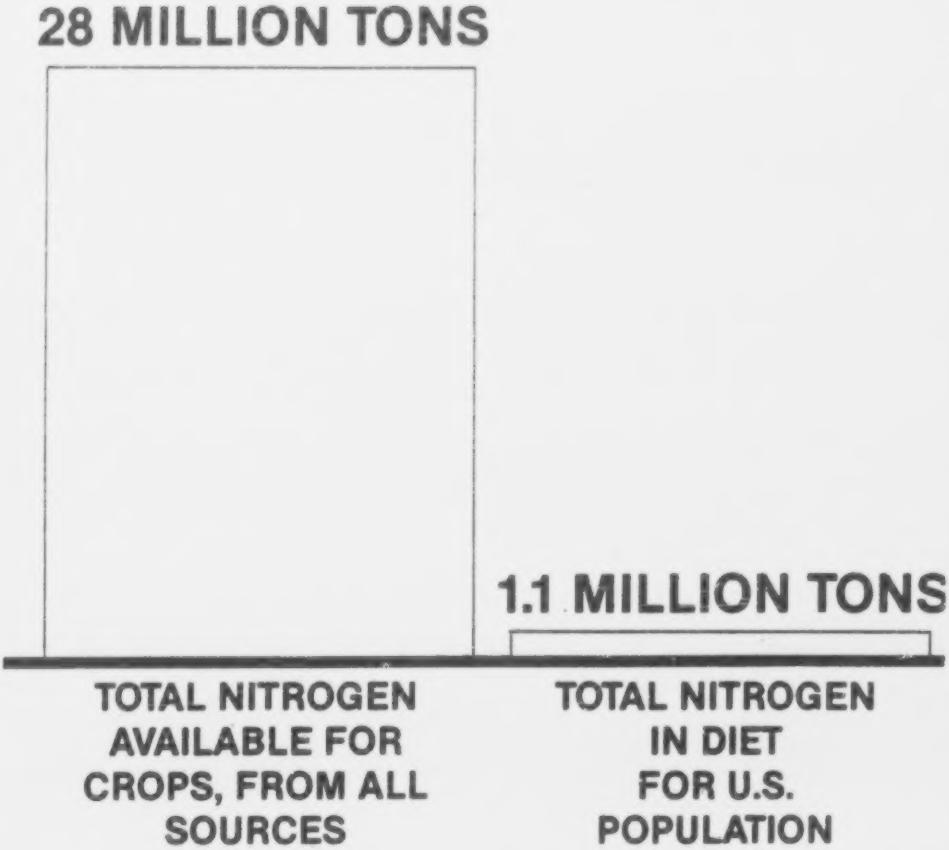
NITROGEN SUPPLIED BY COMMERCIAL FERTILIZER VS. NITROGEN SUPPLIED BY CROPS

(PER ACRE)



Mr. GIESE. Expressed as nitrogen, the average consumption per person of protein is 12 grams per day. In a year's time, this nitrogen intake for the United States equals 1.1 million tons per year. Compare this with the 28 million tons of nitrogen available for crop production, only 1 pound of nitrogen reaches us in our food for each 25 pounds of nitrogen available to the crop itself as illustrated in the chart entitled, "Nature's Efficiency versus Man's Dietary Needs."

NATURE'S INEFFICIENCY VS. MAN'S DIETARY NEEDS (YEARLY BASIS)



Mr. GIESE. As you can see, despite the tremendous strides made for increased farm productivity, we in modern agriculture are handicapped by the limitations imposed on us by nature itself.

A fact we must realize, whether we are producers of commercial fertilizers or producers of Federal legislation, is that there is no complete recovery of applied nitrogen by any crop. For example, major grain crops recover 50 to 70 percent of the applied nitrogen.

We are limited by the ability of the plant root systems themselves to recover nitrogen in the soil. For those who want spinach and lettuce in vegetable salads, as an example, and for those who want strawberries in their ice cream, there is more bad news. Such plants only recover about 25 percent of the applied nitrogen.

Thus, as long as we want to produce the foods of our current preference, there will continue to be large requirements of nitrogen for the production of these crops, and there will continue to be losses to the environment until a geneticist comes up with, through genetic engineering, super efficient plants for recovering nitrogen from the soil.

The leadership of the U.S. fertilizer industry, through the Fertilizer Institute itself, has faced these facts and others regarding the use of nutrients. As documented in my written statement, two programs of the agronomy division of my own company, as a major fertilizer marketer, illustrate industry efforts to ensure the judicious and responsible use of fertilizer products by our customers.

First, our cropland agronomist program provides guidance to our member-dealers for use with their farmer customers on optimum nutrient application rates through training and consultation with professional agronomists on our staff. Our agronomists rely on the latest scientific information, along with computerized data systems, to develop recommendations on fertilizer use.

Second, Land O'Lakes conducts extensive research at our research facility called, "The Answer Farm," in north-central Iowa. We conduct both short- and long-term research on improving nitrogen utilization by plants. For example, our researchers are investigating the effects of tillage practices on nitrogen uptake, as well as evaluating the nitrogen uptake efficiency of different corn varieties themselves.

Overall, the Land O'Lakes' system employs over 200 professionally trained agronomists in seven upper Midwestern States in which we market fertilizer.

In conclusion, I would submit the following:

No. 1, evidence currently available shows that as long as we will be the beneficiaries of abundant nutritious food made possible through fertile, productive soils, there will be some losses of nutrients, it is unavoidable, regardless of the source, to the environment.

We have a responsibility to minimize these losses as we seek to maximize recovery of the nutrients themselves.

No. 2, informed management decisions by individual farmers, based on local climatic cropping and soil conditions, will be the best means of minimizing nitrogen losses to the ground water. We simply see no way that any single piece of legislation could address the nearly infinite number of conditions involved to best manage nutrients in the environment in every area of the United States, or which could dictate to farmers how they manage their own farms.

No. 3, there is a wide array of Federal research efforts underway to study ground water. Designating a primary responsibility among the Federal agencies, such as the Agricultural Research Service of the USDA, could improve the rate at which we further identify practices in agriculture that can minimize nutrient losses.

All of us in the room share in our national goal of preserving and protecting America's natural resources, One of the most precious of those being our water supplies. As we seek such ideals, we need to focus on rational formulas which achieve our ends, not one which renders judgments that have yet to be verified, and could actually reduce the national heritage we seek to preserve.

Farmers have an economic imperative of producing at peak efficiency. Consumers expect abundant food supplies at low cost. Both groups share concerns about the environment. Commercially applied nutrients satisfy the first two needs, and the industry which provides the product is working to exceed public expectations related to environmental protection. Let's work together. As always, we stand ready to act and to respond.

Thank you.

Senator **DURENBERGER**. Thank you very much.

George Hallberg.

STATEMENT OF GEORGE HALLBERG, CHIEF, GEOLOGICAL STUDIES, IOWA GEOLOGICAL SURVEY

Dr. **HALLBERG**. Thank you, Senator.

I am George Hallberg from the Iowa Geological Survey in the State of Iowa. I want to address, in brief, the findings of some of our research programs, as well as a few comments about resource needs at the State level.

During the past 5 years in Iowa, we have conducted what some have called some of the most intensive research on the relationships between agricultural chemicals and ground water quality that are ongoing in the country. Our work has shown clearly that nitrates, and a variety of pesticides are leaching through the soil into shallow ground water and are now found in many of Iowa's ground water aquifers. These ground waters supply drinking water to both cities, as well as private individuals.

As we look on the local level, certainly, we have a variety of problems related to septic tanks and other waste disposal problems, and we are quite concerned with some of the severe problems we are seeing locally related to the local farm chemical supply dealerships.

One of our concerns that I primarily want to address, however, is the regional contamination of ground water that we are seeing, which is the result of conventional usage of agricultural chemicals and constitutes a nonpoint source pollution problem.

A great deal of our work and research has been focused in northeast Iowa, particularly the Big Spring Basin, and perhaps an undue amount of attention has been addressed there. People are considering that this is an area with unique problems, and it is not. Clearly, the problems that we are seeing are occurring throughout the

State of Iowa, and throughout the Corn Belt. In Iowa at least, the problems are worse in other parts of the State.

Our work has tried to document the background or natural levels of nitrogen in our aquifers, and we have found basically that it was quite low, often less than one part per million as nitrogen.

Over the past 20 years, the nitrate concentrations we have seen in ground water have increased in a direct and linear fashion, paralleling our increased use of nitrogen fertilizers. If we look at some of our detailed studies, in the Big Spring Basin, for instance, I think the magnitude of the losses is also instructive. In that region, losses of nitrogen as nitrate, in both surface water and ground water, are equivalent to about 33 percent, to over 50 percent in wet years, of the amount of nitrogen fertilizers being applied.

This is not to imply that all of the nitrogen being lost in water is coming from fertilizer nitrogen, but it is in response to the large amounts being applied in relation to the nitrogen balance.

The losses that we are seeing are clearly an economic concern, as well as an environmental one in Iowa. In Iowa, when we look at farmers spending $400 million a year on fertilizer, and when perhaps as much as 50 percent of that, or more, is not going into grain production, there is clearly room for some added economic efficiencies.

Pesticides, we are also finding in ground water, most particularly herbicides, much more extensively than we anticipated. No long-term data exist on pesticides in ground water, but some data we have been able to put together in Iowa, going back to 1968, begin to suggest that pesticide residue in ground water are likely increasing year by year, perhaps analogous to the rise in nitrate that we saw a decade or so ago.

As with any nonpoint source problem, the potential scope is vast. We have urban and rural combinations. Municipal public water supplies are affected, as well as rural ones. Surface or stream waters are also affected. In the humid parts of the country, the base flow of most of our surface waters comes from ground water as well. In some streams, we have gone to great length to clean up our point source problems, but we are still seeing high nitrate because of the ground water flux into these streams.

The problems that we are seeing, the leaching of agchemicals into the ground water, are occurring in large part because we have not fully understood some of the details, important details, of the movement of water through the soil, as well as some details of the behavior of chemicals in the soil, and how they may be leached.

That understanding is clearly evolving, and as we are learning about those natural processes, we feel that we are at a point where we can begin to take advantage of those processes, incorporating these processes into management systems that will help us to minimize our losses.

We have to develop a more holistic approach to agricultural management, to combine our desires and our needs for soil conservation and surface water protection with ground water protection as well. Some of our traditional approaches to soil conservation, in turn, have actually increased infiltration, and will increase the leaching of nitrate, potentially, to ground water. We have to balance these needs in both our research and implementation programs.

Iowa, to begin to address these problems, has developed a 7-year research, demonstration, and implementation program that we are calling the Big Spring Basin Demonstration Project.

We focus again on this area that we call the Big Spring Basin, not because of unique water quality problems in the area, but because of the unique setting of the area, that allows us to study ground water and in particular its relationship to agriculture in ways that simply can't be done elsewhere.

The program involves every natural resource agency in the State. It involved agribusiness. It involves individual farmers. It involves Federal agencies, ASCS, SCS, in particular, as well as our regional office of EPA. It involves all of our university personnel from the agronomy department and experiment station to our Institute for Rural Medicine.

We hope, and we feel quite confident, I guess, at this point that such a program can go a long ways toward developing the kinds of needed technical, as well as institutional, arrangements we need to focus on these problems. We have to develop management practices, and we have to prove them in dollars and cents to the farmer that these can work.

This program is designed to go for 7 years. We estimate its cost at about $6.8 million. Now $2.4 million of that is being put up by State agencies, and to date about $200,000 has been put up by cooperating Federal agencies, mainly for cost-share moneys.

We need an additional $4.2 million, roughly $600,000 a year, which we are seeking from Federal agencies. The sum total of what we are talking about still trying to get for a 7-year program is less than 1 percent of what the Iowa farmer is currently spending on agchemicals in a single year. I think that the potential efficiencies there are obvious.

To sum up, I think for the first time, our agronomists, our economists, right on down to our geologists, feel that we are in a position, with what we have learned, with what we are seeing, both on an economic basis, as well as a technical basis, that we are in a position to make some real strides toward improved agricultural management, improving our efficiency, and developing the needed means and institutional arrangements that we need to balance our need for efficient agricultural production and our need for safe drinking water.

Thank you.

Senator **DURENBERGER**. Thank you very much.

Dr. **ARMY**.

STATEMENT OF DR. THOMAS ARMY, DEPUTY ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Dr. **ARMY**. Mr. Chairman, Senator Baucus, I am Tom Army, Deputy Administrator of the Agricultural Research Service, U.S. Department of Agriculture. I appreciate the opportunity to meet with you this morning to discuss this important issue.

ARS has a longstanding record of activity and achievement in soil and water conservation research and crop production research. We continue to have substantial research programs directed toward the solution of technical problems related to agricultural water management and quality.

As we all know, agriculture is a primary source of food and fiber for all of us. Fertilizers play a key role in this agricultural production and will continue to do so. I want to emphasize that ARS considers the use of fertilizer nutrients essential to modern agriculture, and high technological agriculture, both now and in the future.

At the same time, we recognize that there are some water quality problems that can be partially attributable to crop production practices. One of these problems is high nitrogen levels in ground waters. Nitrogen and other plant nutrients in themselves are not problems, but when soil nutrient concentrations exceed crop requirements, or are applied incorrectly, the potential for nutrient loss and water pollution exist.

Managing the concentration of plant nutrients in the soil is a complex process. In addition to fertilizers, naturally occurring processes are important sources of nutrients. We heard some of that from the previous speakers.

Examples of these processes are biological nitrogen fixation and deposition in the soil, mineralization or transformation of soil organic matter into inorganic chemical forms, and leaching of nutrients from the soil due to infiltration and drainage of excess precipitation. These natural processes occur all the time independent of agricultural practices and processes.

In some situations, virtually all of the nitrogen and other nutrients in ground and surface waters can be traced to natural sources and processes. In other situations, agricultural sources of nutrients only supplement natural sources. In many cases, nonagricultural sources, such as municipal wastes, are the primary source of nutrient contaminants.

One of the primary challenges to our agricultural research programs is to help understand the relative magnitude of these various natural and manmade sources of nutrients in water, and the interrelationships between them so as to have a true understanding of the problem.

Simultaneously, we are working to fine tune agricultural production practices to optimally meet crop fertilizer requirements and at the same time to minimize nutrient waste and loss from soils.

Improved agricultural practices hold great promise to be the solution to the water pollution problems, even some of those due to natural causes not related to agriculture.

In our ARS research programs, we are developing systems that enhance the recycling of plant nutrients to minimize excessive fertilizer applications. We are developing models that predict the rates of conversion of nutrients and chemicals to soluble forms, the movement of soil water through the system, and the transport of nutrients and chemicals through the soil profile to the ground water.

These models will enable reliable predictions of optimal fertilizer applications under a wide array of climates, soils, and crops. Using new biotechnology tools of genetic engineering, we also have research programs underway to improve the biological nitrogen fixation process.

These new technologies will enable farmers to use resources more efficiently, to reduce production costs, and to reduce the nutrient losses that affect water quality.

I have emphasized nitrogen in my testimony because nitrogen in its most common form, nitrate, is water soluble and is the primary nutrient that is affecting the quality of ground water.

Currently, ARS allocates about $4.6 million annually for soil fertility research related to nitrogen and associated pollution problems. About 70 percent of this research is on identifying and quantifying the processes involved, including nitrogen cycling, transport processes, and the role of soil micro-organisms. An additional $1 million is being expended annually on biological nitrogen fixation research.

Our research programs are planned cooperatively with university and fertilizer industry scientists. About 1½ years ago, we put together a working group in ARS of a multidisciplined team of scientists, involving physicists, chemists, microbiologists, plant physiologists, and fertilizer specialists. In the report from that working group, we have listed our priorities and problems as we see them. With your permission, Mr. Chairman, I would like to enter a copy of this in the record.

Senator **Durenberger**. Without objection, it will be made part of the record. (See p. 302.)

Dr. **Army**. This, Mr. Chairman, concludes my testimony. I want to say, thank you, and I will be pleased to answer any questions anybody may have.

Senator **Durenberger**. Al, let me start with you.

My staff tells me that some of the other staff around here were surprised to find out that Land O'Lakes wasn't just a dairy co-op, which we consider it in Minnesota, and out here that it wasn't just a source of butter. They can't quite figure out why you are testifying for the Fertilizer Institute.

Maybe you could describe the industry just a little bit. Are nitrogen fertilizers manufactured, if so, by whom? How are they transported, distributed, and that sort of thing.

Mr. **Giese**. There are three basic plant nutrients—nitrogen, phosphates, and potashes. They come in three basic forms. Anhydrous ammonia as a nitrogen product is a gas. Then all three major plant nutrients come in the form of dry blends or liquids. So there is any combination of those used throughout the crop-producing areas of the United States.

The fertilizer industry itself, in producing those three basic plant nutrients, is comprised of nitrogen production facilities, and the building block for all nitrogen fertilizers is natural gas. All forms of nitrogen fertilizers start from natural gas, then into anhydrous ammonia, which is a gas, and then converted to the other forms.

Phosphate production is centered in Florida, where a large percentage of the world's phosphate reserve lie. It is open-mined. Most of the Nation's phosphate plants operate in or around the Florida area, with some exceptions.

The United States is essentially the world's largest producer of phosphate fertilizers, and approximately half of domestic production is exported to other countries around the world.

Potash is deep mined. The majority of the world's reserves lie in Canada, basically in Saskatchewan. Both domestic and Canadian companies are involved in mining and manufacturing potash fertilizers that are then moved into the United States.

Fertilizer moves via the major waterways, which probably would comprise most of the phosphate movement into the Midwest. Anhydrous ammonia moves by tank car and pipeline. Potash moves by rail car and truck. All forms eventually move by truck from a terminal located near the point of use to a dealer distribution network. The dealer would custom blend the fertilizers to fit the prescription required based on a soil test and apply the fertilizer via means of floatation application equipment or, in the case of anhydrous ammonia, injected directly into the soil.

The industry is made up of producers who mine and manufacture the material, of distributors and wholesale marketers.

The point on Land O'Lakes, Land O'Lakes is an agricultural cooperative, best known out here for Land O'Lakes butter, and so on.

We are involved in two major functions for our farmer members. As an agricultural cooperative, we are owned by the farmers and the member cooperatives, retail cooperatives, that we serve. We provide the inputs to agriculture, and that essentially is the input necessary for livestock production and agronomic production.

We are a major marketer in the upper Midwest of crop inputs, including fertilizer, agricultural chemicals, and seed. We would be considered in the industry a wholesale marketer.

The producers mine and manufacture the product. There are wholesale marketers. There are independent retailers who take it on to the retail market. Land O'Lakes would be a wholesale marketer with major investments in production through an interregional cooperative that is involved in mining and manufacturing.

Our competition, or others in the market, would be independent producers and corporations involved in any or all of those functions. All of the functions in the industry are represented by the TFI. Approximately 95 percent of the producers, wholesale marketers, and retailers are represented here.

Senator **Durenberger**. Thank you very much.

Dr. Hallberg, in your written testimony, you mention that much of northeastern Iowa is in a karst region, which is true of southeastern Minnesota. It is a unique kind of geological formation that presents special ground water problems.

Would you, for the record, briefly describe the karst geology? I also understand that you have been working with some of our people in southeastern Minnesota and know some of the problems they are facing, which you might also describe for us.

Dr. **Hallberg**. Yes, sir.

By karst, we are talking about a term that geologists use to describe a landscape in certain terrains where limestone forms the bedrock and is close to the surface. These rock materials are basically salts of low solubility. Over long periods of time, the ground water that percolates down through them actually dissolves away part of the rock and opens up large openings, conduits in the rock, which in the extreme case which we are most familiar with, in the form of caves.

As these processes and things like conduits collapse, solution openings make their way to the surface. The unique aspect of the karst in this context is that it also opens up closed depressions at the land surface, things that we call sink holes. Sink holes swallow surface drainage, whole streams in extreme cases, from the land surface, and allow surface waters to enter directly into the ground water system.

In these situations, we see some very unique water quality problems, if we relate it to agriculture, again, that are concerns with nonpoint source problems in surface water. The runoff of agricultural land, carrying with it soil particles, organic matter, various organic wastes and microbial pathogens, and sometimes high concentrations of surface applied chemicals, can go very directly into the ground water system. So we see some very unique kinds of water quality problems in karst areas because of that.

These are problems that are being looked at in both southeastern Minnesota as well as northeastern Iowa. Even if we just consider some of those unique problems, karst areas underlie important agricultural areas across the whole eastern part of the United States, most of southern Indiana, large parts of Kentucky, parts of Ohio, much of Florida. These types of areas also come into play.

Even these kinds of problems, though we talk about them as unique, are fairly extensive.

Senator **Durenberger**. All of this testimony about alfalfa and soybeans as polluters puts me in mind of the 1980 Presidential campaign. Somebody said something about 90 percent of air pollution coming from trees, and then somebody hung a sign around a tree in California that said, "Stop me before I kill again."

It reminds me, with the kind of testimony we have in hand, somebody is going to suggest we have given a whole new meaning to the movie, "Killing Fields."

I wonder, therefore, if the witnesses might give us some specific cases where soybeans or alfalfa have contaminated a water supply. I don't want to make a new movie out of this, but do we have any evidence of that happening?

Dr. **Army**. You can't distinguish where the nitrogen comes from anyway by the time it hits the ground water. Nitrate is nitrate.

Dr. **Hallberg**. Part of the problem that we are really talking about is total nitrogen management. We have sources of N coming from leguminous crops that are already in place. What we have to do is balance that with the inputs that we can control.

Again, if I go back to our detailed studies in the Big Spring Basin, we have a fair amount of rotation that goes on there. When we have calculated—We look at yield studies, for instance, after a 3-year rotation of alfalfa, one can produce quite a viable crop. This past year, we produced 140 bushels per acre of corn with no fertilizer after alfalfa alone. Yet we are finding, over time, people have forgotten what we rotated crops for, and on the average in that region, people are applying a little over 100 pounds of nitrogen after a 3-year stand of alfalfa.

That is a controllable input, and that is part of the problem. We have to deal with it in a total manner.

Mr. **Giese**. I think that the point we are making, illustrating the nitrogen that alfalfa and soybeans add back to the soil on a crop rotation basis, is that nitrogen doesn't come solely from the application of commercial fertilizers.

Through proper agronomic practices, as was indicated here, you would not apply the same amount of commercial nitrogen fertilizer to the corn crop coming out of an alfalfa or soybean rotation that you would on a continuous corn basis.

Through proper soil testing and agronomic consulting, you adjust those so that you only have the amount of nutrients in the soil required for that crop for that year in terms of nitrogen.

The problem gets down to the recovery of applied nitrogen by the crop itself, and that gets back to nature's design of plants. Corn roots only occupy 1 percent of the soil volume and that accounts for a lot of that conversion rate that we were talking about, with 28 million pounds available and only 1.2 million make it into the food chain.

Senator **Durenberger**. The standard, as I pointed out in my opening statement, the standard for nitrate set by the EPA is a health standard which was designed to prevent blue baby disease, with some margin of safety. I guess we agree that it is an appropriate standard.

Is there any one of you who wants to say that the standard should be reexamined, that is, that it is too high or too low, and that there isn't any health problem?

Dr. **Hallberg**. There has been a fair amount of controversy and a lot of comment, I think, in recent years about raising that standard. When one looks at that standard in relationship to many other standards that are being set for various chemicals in drinking water, it is not nearly as conservative as many other standards that we are setting.

I don't really see that raising it resolves any aspect of the problem. It has been proposed to be raised really to resolve the hassles and headlines that occur when a city like Des Moines exceeds that standard.

Senator **Durenberger**. Beyond the health problems, are there any other environmental effects that should concern this committee? It seems to me that in some seasons, and in some parts of the country, ground water provides a very large percentage of low streamflow. In the concentrations that we are talking about, is it possible that nitrate is likely to disrupt the stream life, or act as a nutrient when it reaches a lake, or some other water body?

Does anybody have an opinion on that?

Dr. **Hallberg**. With some of the problems that occur, one of the limiting nutrients is quite commonly phosphorous as opposed to nitrate. It is often the limiting factor involved.

As I mentioned briefly, and talk about in the written testimony, it is a factor that we are seeing. In streams where we brought point sources under control, we are seeing high nitrate fluxes come through those surface waters which are, in turn, also used for drinking water. In large part, it is related to the ground water influx into those rivers, which maintain the base flow of the river.

Senator **Durenberger**. If we agree that there is a health problem and that EPA has set some appropriate standards, and we ought to do something to reduce leaching, could we also agree that we have what I might call an efficiency problem, and that is that under current economic realities, according to current agricultural practices, we apply much more nitrogen than our crops need to meet reasonable yield expectations?

Do we agree that if we could economically change the practice, or change the fertilizer form, or change the timing, or some other way improve the efficiency, that we ought to do that, so that we could reduce the threat of ground water contamination and also save the farmers some money while we are doing it?

Is that appropriate for all of us to agree on?

Dr. **Army**. I think there are some opportunities in cropping practices.

Senator **Durenberger**. Any ideas on how big a reduction we might be able to be looking for? Does anybody have a feel for the efficiency or inefficiency in the system today?

Dr. **Hallberg**. It is hard to generalize because of the different crop types involved. I know that some of our agronomists in Iowa—we are looking at corn primarily for grain production—feel that we can certainly increase the efficiency by 30 to 40 percent perhaps in total.

It may be a combination of a reduction of the amount that we put in, and perhaps greater efficiency at keeping it where it is and getting it into grain production.

Mr. **Giese**. As we look at the conditions involving the application of fertilizer, and those conditions can vary greatly within one State, we think that proper agronomic practices through education, as well as the proper research, we suggested that that research be conducted on an ongoing basis, that is more of the answer.

We don't see that there is a wholesale overapplication of fertilizer. In fact, most of our programs lend themselves to absolutely maximizing the inputs into the crop production system so that we don't have exactly what you are talking about. That has changed a lot in the last 10 to 15 years through soil testing and acronomic consulting services, and just better delivery of technical data for decisionmaking to the farmer himself.

Senator **Durenberger**. I have a couple more questions along that line that I am going to submit to you all for the record. I will turn to Senator Baucus for questions.

Senator **Baucus**. Thank you, Mr. Chairman.

Gentlemen, I am trying to determine the degree to which commercial fertilizer is a problem in ground water. Dr. Hallberg, you seem to say that tests show that there is a problem here to some degree.

The question that I first have is this: To what degree would there be a nitrate problem in ground water if there were no application of commercial fertilizer?

Let's assume that we had no fertilizer, that man did not apply fertilizer to the crops to raise the crop production. I am trying to isolate where the problem is here. Assuming no fertilizer, how much of a nitrate problem would there be in ground water?

Dr. **Hallberg**. There would be the local problems that we see related to septic tanks. We have cleared up a number of our larger municipal waste disposal problems, but we still would have some local problems related to heavy manure usage. We would not see the regional—by regional I am talking statewide—problems that we are seeing occurring in Iowa. Sixty percent of the total land area in the State of Iowa in any given year is under row-crop production that is receiving chemical application.

Senator BAUCUS. What is the greater source of nitrate in ground water? Is it septic tanks or is it commercial fertilizer?

Dr. HALLBERG. I would say that it is in the widespread usage of nitrogen in grain production in Iowa. That includes, as we said, fertilizers, but also the other forms of Nitrate. We have to take those into account. The controllable form, of course, is fertilizer that we choose to apply.

Senator BAUCUS. I am trying to figure out, among the the man-caused sources of nitrate in the ground water system, which is the greater source and, therefore, the greater problem?

Dr. HALLBERG. Senator, in Iowa, I would have to say that it is fertilizer.

Senator BAUCUS. Fertilizer is greater than septic tanks.

I know that you have just been looking at Iowa, but you have still been working in this area. What is your gut reaction as to what the answer to that question would be generally nationwide?

Dr. HALLBERG. The same kind of findings that we have can be shown nationwide. A decade ago, we were questioning the role of fertilizers in agriculture as far as the nitrate in ground water. We were questioning whether or not we were seeing increasing nitrate levels in ground water. But there has been good research across the whole world that has demonstrated the same factors.

Septic tank problems, to us, it is difficult to quantify that. We have a lot of them out there. We have even public water supplies that are affected by septic tanks and cesspool effluents in concentrated areas. The high nitrate concentrations in those water supplies were at about the same level in 1949 in a couple that we looked at.

Senator BAUCUS. What I am trying to find out, do you think that commercial fertilizer is the biggest problem? Is it twice the problem, three times the problem, just a rough guess?

Dr. HALLBERG. I would say that it is a much greater problem, but I couldn't give you a number on it.

Experiment farm studies, if I may, show the same phenomena, across the Corn Belt at least. Once we get above about 50 pounds of nitrogen per acre application, we begin to see a linear increase in the amount of nitrogen that is either lost or left remaining in the soil potentially to be leached. So the effects are the same.

Senator BAUCUS. Let's look at the other potential problems, herbicides and pesticides. Do you think that the application of herbicides and pesticides is a greater source of ground water contamination compared with commercial fertilizer or not?

Dr. HALLBERG. I think that they are perceived that way. At this point in time, we are not sure. We do not know what the concentrations of pesticides that we are currently seeing in ground water—we don't fully know what those mean.

Senator BAUCUS. I am just asking you for your best guess.

Dr. HALLBERG. We are concerned about that in the long term, but part of the concern, in talking with some of our preventive medicine people and epidemiological people, is in the combinations we are seeing of pesticides with high nitrates and other manmade chemicals in ground water. Some of these things, at least in the laboratory, are known to combine to form products that are known carcinogens, and things of that nature, even in lower concentrations.

Senator **Baucus**. Even as I hear you, you are saying that there is a greater problem with pesticides and herbicides than there is with commercial fertilizer.

Dr. **Hallberg**. Right now our bigger concern in Iowa is with nitrates because the herbicides and pesticides are in very low concentrations. We are concerned about those, but we feel that they can be dealt with together with nitrogen in terms of proper management, chemical management, tied in with our other considerations.

Senator **Baucus**. Mr. Giese, would you agree with Dr. Hallberg's statement that there is a greater problem with commercial fertilizer than there is with septic tanks or other sources of nitrates in ground water?

Mr. **Giese**. I am not an agronomist, so I would not be as qualified to comment on that as he would.

We know that nitrates are naturally occurring solutions in ground water. To the extent that they are naturally occurring, I am not aware of any data that reliably show what impact commercially applied nitrogen fertilizers have on that.

You have to take into consideration the parameters of soil type, quantity, timing of application, and water percolating through the soil.

Senator **Baucus**. I know that it is complicated. There is a lot to consider there.

Mr. **Giese**. That is right.

Senator **Baucus**. I am just asking you, when you add it all together, and you crank it all up in your head, what is the bottom line?

Mr. **Giese**. I would say that the bottom line from our standpoint is that we need to continue to move toward more effective uses of nitrogen fertilizers applied to the soil.

Senator **Baucus**. No one can disagree with that. The bottom line I am searching for is whether you agree with Dr. Hallberg's statement, that there is a significantly greater problem with commercial fertilizer, and the application of commercial fertilizer causing nitrates in ground water compared with other man-made and man-caused sources, let's say, septic tanks.

Mr. **Giese**. I am not qualified to make that judgment.

Senator **Baucus**. But you are in the field.

Mr. **Giese**. Yes, sir.

Senator **Baucus**. This is your business.

Mr. **Giese**. Yes, but I am not an agronomic expert. I am representing the industry from a business and a responsibility standpoint, and communicating what the industry itself is doing to deal with the problem of nutrient contamination of ground water.

Senator **Baucus**. But you must have some sense of this.

Mr. **Giese**. I am not qualified to make that judgment. That is a scientific judgment.

Senator **Baucus**. I won't hold you to it.

Mr. **GIESE**. It is a scientific judgment.

Senator **BAUCUS**. I would encourage you to look into it because it is obviously a concern to a lot of people.

Mr. **GIESE**. Yes, sir.

Senator **BAUCUS**. I have a hunch that you have thought about it. I would encourage you to think about it more so that you can start talking about it, too.

Mr. **GIESE**. We do have agronomic experts on our staff to deal with that very question. We have not, at this point, been able to render what we would consider to be a fair and equitable judgment on that.

Senator **BAUCUS**. Thank you.

Senator **DURENBERGER**. Let me follow that up just a little bit.

If Bill Larson had been able to be with us today, I would probably be asking this question of him, but maybe one or the other of you can describe for us the fate of nitrates once they reach the ground water supply. Does the contaminant stay in its nitrate form, or is it transformed, turned back into the nitrogen cycle? Does nitrate move less rapidly or more rapidly than the water that it is in? Does it stay near the top of the aquifer, or does it move down rapidly? What happens to it once it reaches the ground water supply?

Dr. **HALLBERG**. Once nitrate has reached the ground water system, there are several things that could happen, which I will mention, and then I will talk about what we see happening.

The potential for any kind of nitrogen-ion in water, there is potential for absorption, there is potential for degradation of that chemical, and there is just the continued potential for it to travel through the system.

In the ground water environment, especially in the bedrock aquifer, there is very little absorption that takes place, particularly of something like nitrate. Nitrate is very mobile in water. It travels right with the water and displaces with it.

In some settings, looking over research from really all around the country, denitrification does occur in the top of some ground water systems. By denitrification, what we are talking about is a process that is catalyzed by microbes in the presence of organic matter which takes the nitrate and breaks it down, back into nitrogen gases. It can then be released back up through the soil.

We have settings where we can document this happening, but it is very localized.

In more of our aquifers, what we see happening is a slow transmittal of nitrate through the ground water system. In many areas at the current time, because of the nature of ground water flow systems, the nitrates are concentrated in the uppermost parts of these aquifers. Depending on the nature of the aquifer it will only be a matter of time before they are diffused and dispersed throughout that system. As long as the inputs keep up, we will be moving them through the ground water system.

Our feeling is, in our deeper bedrock aquifers, we are very limited in terms of the possibilities for removal or degradation of nitrate. We expect that it is a matter of time until it moves deeper through the system.

Senator DURENBERGER. In response to Senator Baucus's questions, you talked about septic tanks in Iowa. What about feedlots. Do you want to tell us what is going with regard to feedlots, if they have been a problem in Iowa, and what you have done about it?

Dr. HALLBERG. Again, they certainly create some problems on the local level but not on a regional level. In many parts of the State, the cattle population has decreased over time. In some areas, the status quo is maintained. In terms of feedlots, certainly we have concentrated cattle, where we used to have more dispersed cattle.

In the largest of the feedlots, I can't remember the exact figures, but those are regulated by our State department of water and waste management, they do have to have a containment and management program for the manure problems.

Clearly, we have problems caused by feedlots on the local level. Again, the regional problems that we are seeing, we can't relate to feedlots.

Maybe I could reflect on that question with an example, if you would like, that kind of ties in with Senator Baucus' question as well.

If we look at the Big Spring Basin, where we have been monitoring intensively now for over 4 years, we have the historical water quality data which takes us back into the 1950's. From what data we have in the 1950's and 1960's, which is more or less preagriculture as we know it today, preheavy use of nitrogen fertilizers, anyway, the nitrate concentrate in ground waters during that period of time were within the realm of about three to four parts per million as nitrogen.

Cattle populations and manure generation have increased about 30 percent over time in that area. The rural population, in terms of septic tanks, has really gone down over that same time frame. We have alfalfa sources, and things like, but in about the same amount as we had 20 years ago. We have primarily increased our total corn acreage, and increased our fertilizer and nitrogen usage in that area by about two-and-a-half times.

Over that same timeframe, from the late 1950's to the present, our nitrogen concentrations in ground water have gone up about two-and-a-half times, in direct increase with the use of fertilizer.

Again, every bit of nitrogen that comes out of the bottom of the soil profile doesn't mean that it is fertilizer nitrogen, but that is our controllable input.

Senator DURENBERGER. Dr. Army, you indicated that the budget for the ARS program for soil fertility research is about $4.6 million annually. Past experience would indicate that the water quality aspects of farming practices have not always been the focus of Federal agriculture programs.

What portion of the $4.6 million currently contributes to our understanding of how to prevent ground water contamination?

Dr. ARMY. Now, I think we are refocusing a lot of the fertility that we have been doing directly to the fertilizer efficiency usage question, which relates directly to ground water, especially in the nitrogen area. We are giving ground water a much higher priority than it had 2 years ago.

Senator **Durenberger**. How many of those dollars are devoted to ground water contamination?

Dr. **Army**. We figure about $5 million relate directly to ground water. We are spending more than that on the total farming practices.

Senator **Durenberger**. You think that about $4.6 million is going into ground water contamination.

Dr. **Army**. Yes.

Senator **Durenberger**. Gentlemen, we are dependent, not only on our own expertise, but on yours also, to do this right. If you could add any other dimensions you might want to add to the testimony, please feel free to do so.

You have the gratitude of the subcommittee, the committee, and hopefully, eventually, of all of us for the efforts that you have put in here today, and we thank you very much.

[Whereupon, at 11:40 a.m., the subcommittee adjourned.]

[Statements and other material submitted for the record follow:]

TESTIMONY OF JANE L. BLOOM ON BEHALF OF THE NATURAL RESOURCES DEFENSE COUNCIL

Introduction

This testimony is presented on behalf of the Natural Resources Defense Council (NRDC), a national nonprofit environmental organization with over 50,000 members and contributors. NRDC and its supporters nationwide are dedicated to ensuring the protection and enhancement of public health and vital natural resources, and have sought improved protection for the nation's increasingly threatened groundwater supplies. To these ends, NRDC has long monitored and worked to strengthen EPA regulatory programs established under the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, and other laws which affect the quality of present and future drinking water supplies.

We applaud the Committee's interest in developing legislation for groundwater preservation. NRDC believes that more must be done now to address the myriad sources of groundwater contamination that are not adequately covered by existing law.

Although many of the above-ground activities that threaten groundwater, such as surface disposal of hazardous substances, are well understood and have received substantial public attention, one method of subsurface disposal, known as underground injection, may present insidious but unseen risks to underground water supplies.

The testimony that follows presents NRDC's concerns about the intensive and increasing use of underground injection and the sobering implications for drinking water sources unless greater restrictions are imposed on this disposal practice. Of particular concern is EPA's thoroughly inadequate Underground Injection Control (UIC) program, which among many other shortcomings, explicitly allows drinking water aquifers to be used as disposal sites for toxic substances and other drinking water contaminants, if they are "exempted" from protection by EPA or primacy states.

I. Underground Injection Is A Widespread Practice That Poses Serious Threats to Groundwater.

Underground injection, defined by the SDWA as "the subsurface emplacement of fluids by well injection," is an intensively used and widespread practice for the disposal of a wide variety of industrial and non-industrial wastes. These include hazardous and radioactive wastes, brines associated with oil and gas drilling, and wastes associated with mineral extraction, as well as storm and agricultural drainage wells, and multiple-use cesspools.

There are an estimated 221,000 injection wells in the United States today.[1] Injection through at least one of the five "classes" of wells indentified by the UIC regulations takes place in nearly every state. For certain types of wastes, underground injection is the predominant mode of disposal. According to EPA, almost 60% (over 11 billion gallons annually) of all hazardous wastes disposed under RCRA are injected into 195 "Class I" injection wells or "deepwells" (i.e., injected into zones below aquifers meeting the SDWA's definition of "underground sources of drinking water.")[2]

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[1] Congressional Research Service, Library of Congress, Underground Injection of Wastes, Rep. No. 83-195 ENR, p. 4 (Oct., 20, 1983) (Hereinafter CRS Report).

An estimated 525 billion gallons of brines used for "enhanced recovery" of petroleum, or removed during oil and gas operations, are also injected each year into approximately 150,000 so-called "Class II" injection wells.[3] The bulk of Class I and II injection takes place in the Gulf Coast and Great Lakes regions, particularly in Texas, Louisiana, Ohio and Michigan.

"Class III" injection wells are used in conjunction with specific mineral extraction activities, including "solution" mining. As of August 1983, there were over 25,000 Class III injection wells.[4]

There are also an estimated 48,000 injection wells in "Class V,"[5] the "grab-bag" category that EPA defines as all injection wells that do not fall within Classes I through IV. These include storm and agricultural drainage wells, multiple-use cesspools, and certain radioactive-waste disposal wells. However, as yet, most states have only just begun to inventory Class V wells. No regulatory requirements have been promulgated under the UIC program to prevent contamination of USDW's by this

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2. Office of Drinking Water, U.S. EPA, Report to Congress on Injection of Hazardous Wastes, p. 5 (1985).

3. Office of Technology Assessment, Congress of the United States, Protecting the Nation's Groundwater from Contamination, Vol. 1, p. 52 (1984).

4. CRS Report at p. 4.

5. Id.

class of injection wells, despite the obvious risks to drinking water that could be posed by some of the contaminants being injected, and the absence of stringent restrictions for some of these wastes under other laws.[6]

Correspondingly, there have been numerous incidents of environmental damage or groundwater contamination due to injection.[7] For example, over half (17 of 32) of the oil and gas producing states have reported cases of groundwater contamination from brines.[8] There have also been many cases of contamination due to injection of hazardous wastes.[9]

A very recent incident that has polluted a drinking water source occurred at Sarnia in Ontario, Canada, and was reported in November of this year. The contamination was discovered when large globules of toxic chemicals, including dioxins, hexachlorobenzene and hexachlorobutadiene, were found floating in the St. Clair River, which crosses the United States/Canadian border and supplies drinking water to both Canadian and Michigan residents. According to newspaper reports, Environment Canada believes that part of the contamination may have seeped up from cracks in the river bottom and may be emanating from 16 abandoned injection wells used by industry to dispose of hazardous wastes.[10]

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[6] EPA's UIC regulations also define one other class of injection: Class IV. Class IV covers injection of hazardous wastes and radioactive wastes directly into or above an underground source of drinking water. Class IV injection is now banned pursuant to §7010 of the 1984 Hazardous and Solid Waste Amendments to RCRA. However, it is important to note that §7010 does not prohibit injection of these wastes directly into or above "exempted" aquifers because the provision directly incorporates EPA's definition of a "USDW," which excludes exempted aquifers.

[7] At least 25 states have documented cases of environmental problems caused by injection. Hearings before the Subcommittee on Public Health and Environment of the House Committee on Interstate and Foreign Commerce, on H.R. 5368, H.R. 1059, H.R. 5348 and H.R. 5995, 93rd Cong., 1st Sess., No. 93-11, pp. 202-203 (March 8-9, 1973) (Statement of Mr. Fri).

[8] Veronica I. Pye, Ruth Patrick and John Quarles. Groundwater Contamination in the United States. Philadelphia, University of Pennsylvania Press. 1983. p.64.

[9] See Gordon and Bloom, "Deeper Problems: Limits to Underground Injection as a Hazardous Waste Disposal Method," pp. 10-19 (1985). (Appended hereto as Attachment A).

Not only have there been many alarming reported instances of pollution, but many undetected cases may also exist. This is partly because under the federal UIC program to date, injection wells have neither been required to monitor nearby aquifers containing groundwater or drinking water sources, nor to monitor the injection zone to determine whether wastes are moving toward usable groundwater.[11] In addition, it may take decades before groundwater contamination resulting from injection is detected, if the rate of groundwater flow is very slow. Thus, undetected pollution of present and future drinking water supplies may now be occurring as a result of injection.

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10. See Attachment B, appended hereto.

11. The SDWA reauthorization bills, passed by the House and Senate and now awaiting action by the Conference Committee, would require EPA to mandate such monitoring. Title II of the House bill, H.R. 1650, provides that EPA must require "monitoring of underground injection wells in such a manner and in such locations as...to provide the earliest possible detection of fluid migration into, or in the direction of, [a USDW]." S.124 mandates the same monitoring requirements as those found in the House Bill, "unless the Administrator or delegated state authority concludes, on the basis of the applicant's demonstration, that such monitoring is not necessary because no potential exists for migration from the injection zone that may be harmful to human health or the environment."

II. The Underground Injection Control Program Enhances, Rather Than Minimizes, The Risks To Groundwater By Authorizing The Exemption Of Drinking Water Aquifers for Use as Injection Sites.

Given the extraordinary prevalence of injection, the massive quantities of wastes being disposed by this method and the demonstrated potential for contamination, the threat to groundwater sources of drinking water could be very great unless stringent restrictions are imposed. At the present time, however, underground injection is subject to remarkably lax regulation under the UIC program. Indeed, EPA's regulations favor this technology based on the unsupportable assumption that wastes injected into the subsurface will never migrate to groundwater. Numerous instances in which wastes *have* migrated beyond the intended zone of containment belie this assumption, and EPA's dogged reliance on it therefore puts groundwater at risk. Nonetheless, the current UIC regulations for Class I wells (*i.e.*, hazardous waste deep wells), for instance, fail to require groundwater monitoring, post-closure care, third party liabilty insurance, or cleanup of wastes leaking from an injection operation, and thus are far less stringent than the RCRA requirements for all other hazardous waste land disposal methods.

Ironically, perhaps the most alarming threat to underground drinking water supplies from underground injection comes not merely from the disposal practice but from a questionable regulatory provision administratively created by EPA: the aquifer "exemption" provision found at 40 CFR part 146.04. In this provision EPA expressly authorized itself, or a state granted primacy under the UIC program, to simply exempt from regulatory protection aquifers that meet Congress' and EPA's definitions of an "underground source of drinking water" (USDW).[12] Once exempted, an aquifer may be used for disposal of various wastes by underground injection.[13] All told, 59 aquifers or their portions have been granted exemptions by EPA or delegated states.[14]

In NRDC's view, the aquifer exemption provision amounts to a license to "write off" valuable future drinking water sources in violation of the SDWA's underlying purpose, which is to prevent endangerment of drinking water supplies. By authorizing injection that will contaminate USDWs, the exemption provision

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12. A USDW is defined by EPA's regulations as "an aquifer or its portion

> (1)[i] which supplies any public water system; or [(ii)] which contains a sufficient quantity of groundwater to supply a public water system; and [A] currently supplies drinking water for human consumption; or [B] contains fewer than 10,000 mg/l Total Dissolved Solids; and
>
> (2) which is not an exempted aquifer."

40 CFR §122.03.

13. According to the preamble of the May 11, 1984 Federal Register, EPA has discretion to limit an aquifer exemption to a particular class of injection. If the Agency exercises this discretion, "other injections will not be allowed unless EPA approves additional exemptions for that aquifer." 49 Fed. Reg. 20143 (May 11, 1984). However, it appears that EPA has also authorized itself to exempt an aquifer for all classes of injection. *See id.* Thus, it is possible that an exempted USDW could be used for disposal of any fluids, regardless of which of the criteria listed in 40 CFR §146.04 formed the basis for granting the exemption.

14. All of the exemptions granted to date have been for Class II (oil and gas) or III (mining) operations, and almost two-thirds have been granted by states. In states where EPA administers the federal UIC program, 22 aquifer exemptions have been granted for Class II operations; and 1 was approved for Class III activities. In primacy states, 36 aquifer exemptions were granted, 30 for class III and 6 for class II. Personal communication with John Atcheson, U.S. EPA, UIC Program, by Wendy Gordon, NRDC (Dec. 8, 1985).

directly contravenes the clear and unqualified mandate of the SDWA, which prohibits all underground injection that "endangers drinking water sources."[15] The Act defines endangerment of a USDW as injection which

> may result in the presence [of contaminants] in underground water which supplies or can reasonably be expected to supply any public water system... and if the presence of such contaminant may result in such system's not complying [with primary drinking water standards] or may otherwise adversely affect the health of persons.[16]

As the legislative history makes plain, the law was intended to prevent contamination and to provide protection "not only [for] currently used sources of drinking water, but also [for] potential drinking water sources for the future."[17] The potential sources that were intended to be protected included both contaminated sources and those "which are not presently accessible for use as a community drinking water supply source."[18] The Act provides no authority for EPA to exempt USDWs for any purpose. Thus, we believe, EPA's creation of an exemption violates the letter and spirit of the Act and nullifies the broad protection it was intended to afford to groundwater resources.

The aquifer exemption criteria specified in EPA's UIC regulations will not, in NRDC's view, adequately protect USDW's that are potential sources of drinking water. The regulations allow a USDW to be exempted if it meets any of the following criteria:

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[15] 42 U.S.C., §300h(b)(1).

[16] 42 U.S.C., §300h(d)(2).

[17] H.R. Rep. No. 93-1185, 93rd Cong., 2nd Sess. 32 (1974) (emphasis added).

[18] Id.

(a) it does not currently serve as a source of drinking water; and

(b) it cannot now and will not in the future serve as a source of drinking water because:

(1) it is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible;

(2) it is siutated at a depth or a location which makes recovery of water for drinking purposes economically or technically impractical;

(3) it is so contaminated that it would be economically or technically impractical to render the water fit for human consumption; or

(4) it is located over a Class III mining area subject to subsidence or catastrophic collapse; or

(c) the Total Dissolved Solids content of the ground water is more than 3,000 and less than 10,000 mg/l and it is not reasonably expected to supply a public water system. [40 CFR §146.04.]

Judging aquifers against these criteria requires pure speculation about future circumstances which cannot be predicted accurately today, including the scarcity of potable groundwater in various regions and the need to use water with high TDS; future advances in treatment technology; and the cost-effectiveness of recovering deeper sources of groundwater in years to come. Further elaboration of why each of these criteria could result in unjustifiable and irreparable contamination of future drinking water supplies is provided below.

A. The Mere Potential For Resource Production Is Not A Valid Reason To Render a Drinking Water Aquifer Unfit For Use.

40 CFR §146.04(b)(1) authorizes an exemption for any underground drinking water source if it could be used for commercial hydrocarbon or mineral production. Under this criterion the applicant for an exemption needs only to demonstrate that the aquifer "contains minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible." Thus, an exemption could be granted for a USDW on the grounds that it might produce oil and gas or minerals, even if no one is presently planning to conduct this activity. More important, the aquifer could be removed from protection regardless of whether it could provide a very high quality (low TDS), readily accessible and inexpensive source of drinking water. Nowhere in the SDWA do we see evidence that Congress intended to allow industry's desire to produce minerals or hydrocarbons for profit to override the public's need to secure an adequate, high quality supply of drinking water for the future.

B. The Present Cost Or Technical Infeasibility of Recovering Drinking Water From Deep Or Contaminated USDWs Should Not Be Grounds For Disqualifying These Potential Future Drinking Water Sources From Protection.

Under 40 CFR §146.04(b)(2) and 146.04(b)(3), USDWs could be exempted if their depth or the extent of "contamination" would make it "economically or technically impractical" to utilize them. Under these criteria aquifers could be relegated to use as disposal sites for wastes, and thus irreparably lost as drinking water sources, solely on the basis of unfounded predictions of future costs. Yet future generations may find it both cost-effective and technologically feasible to tap deep aquifers or cleanse briney or contaminated ones that could not be used today due to economic or technical barriers. Indeed, technology has been rapidly advancing and now exists to treat brackish aquifers with TDS well in excess of 10,000 mg/l, although it was not possible to do so years ago.[19]

As stated above, the drafters of the SDWA explicitly intended that aquifers that are presently contaminated or inaccessible be included within the scope of protection afforded USDWs. Consideration of costs, particularly incalculable future costs, was not authorized as a basis for exempting, and possibly precluding the use of groundwater resources by future generations.

C. There Is No Rational Basis For Excluding USDWs With TDS Content Under 10,000 mg/l Since These Are Potable, Are Now Being Used, And Are Expressly Subject To Protection Under the Act.

Equally troubling is EPA's inclusion of 40 CFR §146.04(c), which authorizes exemption of a USDW for no other reasons than TDS content of "more than 3,000 and less than 10,000 mg/l" and the unprovable prediction that an aquifer "is not reasonably expected to supply a public water system." The legislative history of the SDWA demonstrates that Congress expected EPA to protect, at a minimum, groundwater containing less than 10,000 mg/l of TDS, even though treatment might be required prior to human consumption.[20] Indeed, as EPA recognizes, water containing as much as 9,000 mg/l of TDS is currently being used in parts of the United States, particularly in the Western States.[21] The Agency further "agrees that aquifers containing between 3,000 and 10,000 mg/l TDS can be extremely valuable...."[22] Nonetheless, EPA promulgated this criterion in 1981, in response to a lawsuit by industry challenging the exemption criteria previously adopted by the Agency as too narrow.

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[19] See, e.g., Dupont, Permasep Permeators (brochure). According to Dupont, this reverse osmosis process is capable of treating water containing up to 60,000 mg/l of TDS.

In light of present use, and the obvious potential for future use of USDWs with TDS content under 10,000 mg/l, NRDC believes that in no case would it be "reasonable" to "expect" that such sources will not supply a public water system at some time. Consequently, we believe that this criterion, like the other criteria listed in §146.04, flagrantly violates the SDWA and should be repealed.

D. The Exemption Of A "Portion" Of A USDW Could Threaten The Entire USDW, and Should Not Be Allowed.

The aquifer exemption provision expressly allows EPA to remove a "portion" of an aquifer from protection, while presumably leaving the remainder of the USDW within the scope of regulation. The interconnected character of the underground water system, however, underscores the fallacy of this presumption. Given our present lack of knowledge about the exact nature of and relationships within and among aquifers, we simply cannot define with confidence those portions of an aquifer which are physically isolated from, and do not connect to, other portions. Thus, if one "portion" of a USDW is allowed to be used as a waste disposal site, other portions, including those presently used as drinking water supplies, may become polluted as well.

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[20] H.R. Rep. No. 93-1185, 93rd Cong., 2nd Sess. 32 (1974).

[21] 46 Fed. Reg. 48245 (Oct. 1, 1981). See also 47 Fed. Reg. 4995 (Feb. 3, 1982), citing Claire M. Gesalman, Desalination of Brackish Groundwater, U.S. EPA, Oct. 1981.

[22] 47 Fed. Reg. 4993 (Feb. 3, 1982).

E. The Aquifer Exemption Provision Of The UIC Regulations Should Be Repealed As Soon As Possible.

As stated above, NRDC believes that 40 CFR §146.04, authorizing exemptions of USDWs from protection under the UIC requirements, is unlawful and utterly inconsistent with the need to protect potential drinking water sources for use by future generations. For these reasons, NRDC strongly urges that the aquifer exemption provision be repealed legislatively.

We believe the need to revoke §146.04 is an immediate and pressing one. As stated above, numerous exemptions have already been granted. Moreover, EPA's regulations authorize exemptions for aquifers containing 3,000-10,000 mg/l of TSD to be granted by the 38 states and territories that have full or partial primacy (i.e., states with EPA-approved UIC programs for some or all classes of wells) with only a minimum of public scrutiny and EPA oversight. According to the UIC regulations, exemption of an aquifer containing between 3,000 and 10,000 mg/l of TDS may be approved by a primacy state without publication of notice in the

Federal Register, and the exemption will automatically become final within 45 days if EPA fails to disapprove it. This is because EPA considers such aquifer exemptions granted under EPA-approved state programs to be "minor modifications" of the state program.[23] The potential for abuse of the state's exemption authority is apparent. Yet, this rule makes it extremely difficult for the public at large and for organizations such as NRDC to monitor implementation of the aquifer exemption provision and to identify and counteract misuse of the exemption provision.

In addition, the new requirements of the Hazardous and Solid Waste Amendments to RCRA enacted last year are beginning to go into effect. These are likely to restrict substantially conventional land disposal options for hazardous wastes, such as landfills and surface impoundments. However, there has historically been a bias in favor of, and little impetus at EPA to curtail, underground injection of these wastes. Consequently, there may be even greater incentives to utilize injection for hazardous wastes than ever before, as it is the lowest cost land disposal option available.

The number of applications to open new deepwells is already on the rise.[24] There is also likely to be increased pressure on injection operators to seek aquifer exemptions where formations containing over 10,000 mg/l TDS are not available. Moreover, with the closure of Class IV wells (i.e., those injecting wastes nto or above a formation containing within 1/4 mile a USDW) those who wish to continue injection into a USDW would need to petition for an exemption. This has already occurred. In 1984, three industrial facilities sought an aquifer exemption for "portions" of the Knox Aquifer System near New Johsonville and Mt. Pleasant, Tennessee, to enable them to continue injecting highly toxic and corrosive wastes into a USDW.[25] The chemical companies, DuPont, Stauffer, and Rhone-Poulenc, claimed that the lower portion of the Knox, which was not being used to supply drinking water, was "so contaminated as to be economically or technically impractical to render fit for human consumption," pursuant to 40 CFR §146.04(b)(3).

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[23] 45 Fed. Reg. 20241 (May 11, 1984).

[24] See "Deeper Problems," supra at p. 7.

EPA tentatively granted the aquifer exemption, despite the extraordinary paucity of data submitted to substantiate it. Indeed, the burden shifted to the public to demonstrate why the exemption should not be granted. NRDC and local citizens' organizations presented compelling evidence that the portion of the Knox that industry sought to have exempted was interconnected with parts of the aquifer that were presently being used for drinking water, and that neither the extent of, nor ability to remedy, contamination was adequately documented.[26] As NRDC pointed out, the Agency's decision-making largely discounted the future value of the resource: in calculating whether the portion proposed for exemption would be practical to use for drinking water, EPA only considered a 16 year period. Moreover, the Agency ignored a Corps of Engineers determination that the county will experience acute shortages within the next 50 years. Fortunately, following public comment, EPA ultimately decided not to grant the exemption.

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[25] Such injection was banned as of June 25, 1984 in Tennessee and therefore would have been required to cease unless the aquifer were exempted. 49 Fed. Reg. 20141 (May 11, 1984).

[26] Letter from NRDC to EPA Region IV, which is appended hereto as Attachment C.

Citizens in rural Nebraska, however, were not so lucky. An exemption was granted by the State (and approved by EPA) for a "portion" of the Chaldron aquifer which is not isolated from parts of the aquifer that now serve as the sole source of drinking water for local residents. The exemption had been sought by Wyoming Fuel in order to enable the company to conduct *in situ* uranium mining ("Class III" injection), a process which releases radioactive material, arsenic, and selenium, among other toxic contaminants, into groundwater. Western Nebraska Resources Council, joined by NRDC as *amicus curiae*, has challenged the granting of the exemption in federal court and now awaits a judicial determination.[27]

Conclusion

The breadth and vagueness of the aquifer exemption criteria, their inconsistency with the SDWA and the apparent sloppiness with which exemption applications have been reviewed by regulators to date, all lead us to conclude that the aquifer exemption provision could result in serious impairment of future drinking water sources. We strongly recommend that this enormous loophole in groundwater protection be repealed in any forthcoming groundwater protection legislation. We also urge the Subcommittee to conduct oversight of EPA's administration of the Underground Injection Control Program, particularly with respect to the failure to regulate Class V wells, and the lesser stringency of controls on underground injection when compared to the RCRA requirements for other land disposal of hazardous waste.

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[27] *Western Nebraska Resources Council* v. *Environmental Protection Agency*, No. 85-1431 (filed April 4, 1985, United States Court of Appeals for the Eighth Circuit).

ATTACHMENT A

This attachment, NRDC's report entitled "Deeper Problems: Limits to Underground Injection as a Hazardous Waste Disposal Method," has been submitted for the record. All members of the Senate Committee on Environment and Public Works have previously received copies of the report. Additional copies may be obtained by writing:

Natural Resources Defense Council, Inc.
122 East 42nd Street, 45th Floor
New York, New York 10168

Attachment B

Dow Chemical given permission to vacuum toxic-chemical blob

BY JOCK FERGUSON
The Globe and Mail

Dow Chemical Canada Inc. has been given permission to vacuum up a 900-square-metre blob containing toxic chemicals that was found near the bottom of the St. Clair River near the company's plant in late September.

Ontario Environment Minister James Bradley said yesterday that Dow could begin work as early as Monday, and his officials will carefully monitor the cleanup every couple of hours.

Divers will examine the blob, and if there is any sign of its breaking up and "moving off site, then we'll shut down the cleanup and have activated carbon powder added to the water-treatment plants at Walpole Island and Wallaceburg," Mr. Bradley said.

Highly toxic organic chemicals such as perchloroethylene and hexachlorobenzene, which are known to be in the blob, are adsorbed by finely granulated carbon powder, which is then trapped and held in conventional sand filters. (When a chemical is adsorbed it clings to the surface of the carbon.)

Mr. Bradley told the Legislature that the go-ahead was being sent to Dow by letter after ministry officials had consultations with Environment Canada, the Michigan Department of Natural Resources and medical officers of health from communities downriver from Sarnia that take their drinking water from the St. Clair.

In the interview, Mr. Bradley said he will ask Dow to pay for all costs associated with the cleanup and will "take legal action" to recover any public funds spent if the company will not co-operate.

Dow could not be reached for comment late yesterday.

The minister promised a "rigorous sampling and monitoring program" to determine the effect of the cleanup on downriver communities.

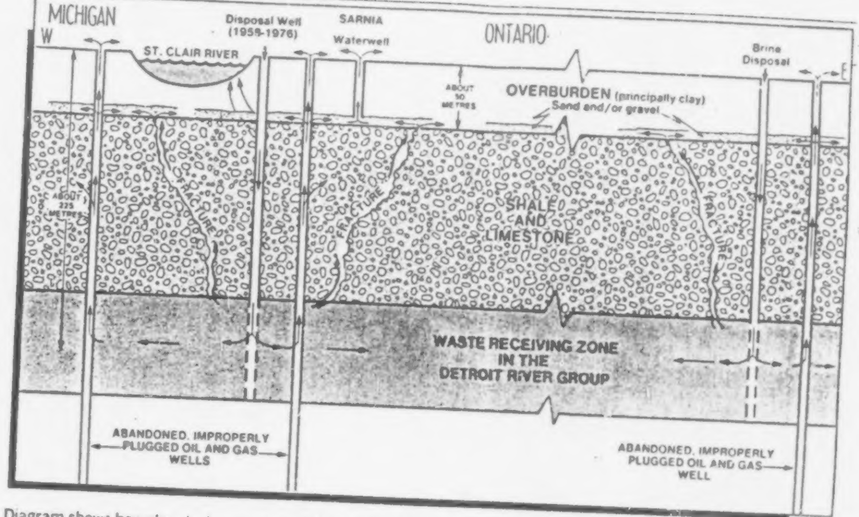
He also promised that the ministry will conduct a "thorough investigation into the improper disposal of chemical wastes in salt caverns" under Dow's plant on the edge of the river.

Dow put more than 41 million litres of wastes into a 300-metre-deep salt cavern between 1968 and October, 1984.

The company says it is simply storing the wastes and has not disposed of them in the cavern, although a company spokesman said he was not sure it was technically feasible to remove them.

Many of the cancer-causing

POISON — Page A16


MICHIGAN
W
Disposal Well (1959-1976)
SARNIA
Waterwell
ONTARIO
Brine Disposal
E
ST. CLAIR RIVER
ABOUT 50 METRES
OVERBURDEN (principally clay)
Sand and/or gravel
ABOUT 225 METRES
FRACTURE
FRACTURE
SHALE AND LIMESTONE
FRACTURE
WASTE RECEIVING ZONE IN THE DETROIT RIVER GROUP
ABANDONED, IMPROPERLY PLUGGED OIL AND GAS WELLS
ABANDONED, IMPROPERLY PLUGGED OIL AND GAS WELL

BERNARD BENNELL, The Globe and Mail

Diagram shows how chemical waste pumped into ground about 225 metres deep may be leaking up into ground water through abandoned oil and gas wells or through caverns or fractures in the rock in the Sarnia, Ont., area.

Poison may come from buried wastes

• From Page A13

chemicals in the wastes that were put into the Dow salt cavern are similar to those found in the blob. A six-week probe of the river bottom off the Dow plant by Environment Canada will try to determine whether there is any evidence that chemicals in the blob are migrating up from under the river.

Between 1958 and 1976, companies in Sarnia's chemical valley pumped about eight billion litres of toxic chemical wastes under pressure into a rock formation that underlies the Sarnia area at a depth of between 190 and 250 metres.

If the chemicals are making their way into the river from the wells, it could create an extremely serious and complex environmental problem, possibly the worst in North America, according to an Environment Canada scientist studying the area.

In the House of Commons yesterday, federal Environment Minister Thomas McMillan rebuked the scientist for pontificating on the possible immensity of the problem.

"The speculation in which he engaged was only speculation and it went beyond his authority and even his competence," Mr. McMillan said.

The underground-leakage theory received a boost this week when Environment Canada divers, using an underwater video camera, found a series of new tar-like blobs in the St. Clair River, 30 metres from the Dow plant.

The divers were looking in the same area where the single large patch, which was found to contain many highly toxic and cancer-causing chemicals, was discovered in September, Mr. McMillan said yesterday.

"We found additional tarry blotches that were much smaller and seemed to be mobile," Mr. McMillan told reporters as he left the Commons.

"In the event that the substances are emanating from (underground waste dumps) in the general area of the St. Clair River, we do have a monumental task on our hands," he added.

The new finding means the problem is "much more complex and technically difficult" than suspected and will tax the resources of "not only my department but of the country to deal with it," he said.

Mr. McMillan said that if it is eventually found that the wastes are coming from operating industries, then the problem will be much easier to deal with.

If the source is known, the Government can easily enforce cleanup orders.

Attachment B

NATIONAL EDITION
The Globe and Mail
142nd YEAR, NO. 42,408 ■ CANADA'S NATIONAL NEWSPAPER ■ WEDNESDAY, NOVEMBER 6, 1985

River blob similar to firm's waste

BY JOCK FERGUSON
The Globe and Mail

Highly toxic chemical waste found on the bottom of the St. Clair River near Sarnia, Ont., is similar to waste pumped down a Dow Chemical Canada Inc. waste well on the river edge, according to company records obtained by The Globe and Mail.

Dow pumped about 41,650,000 litres of hazardous chlorinated organic waste into a salt cavern beneath its property between 1968 and October, 1984, according to its records.

The wastes included many of the same chemicals — hexachloroethane, hexachlorbenzene, hexachlorobutadiene and perchloroethylene — that showed up in an Environment Canada analysis of a 900-square-metre blob of chemicals found Sept. 27 on the river bottom off Dow's Sarnia plant.

Many of these chemicals are unique to Dow, according to Government scientists.

Highly toxic dioxins and furans (a family of chemicals only slightly less dangerous than dioxins) were also found in the river-bottom samples.

However, the dioxins were not present in the material Dow put into the well, according to a company spokesman.

Dow officials say they are certain the well, drilled into an old salt cavern to a depth of about 580 metres, is not leaking into the river.

An unreleased 1984 report done for the Ontario Ministry of the Environment said 18 wells in the area were used by the chemical industry, from 1958 to 1976, to pump liquid industrial waste, many of them highly toxic, into the ground for disposal and storage.

Sixteen of the wells pumped waste under pressure into the porous Detroit River Formation 150 to 250 metres underground. Dow's two wells went into the deep Salinas salt formation under the shallower wells and were not pressurized.

The salt formation contains oil and gas deposits and has been penetrated by many hundreds of old oil and gas wells.

Richard Jackson, an Environment Canada hydrogeologist who is familiar with the geology of the St. Clair River area, said the abandoned wells could provide routes by which the chemicals could migrate upwards into the ground water and eventually into the river.

However, he said, only a lot of expensive drilling into the area under the river will conclusively determine whether the old waste wells are the source of the river-bottom contamination.

Both the company and the Ontario ministry say there is no trace of the Dow waste coming up into a shallow ground-water monitoring well on Dow's property beside the river.

Officials at Environment Canada expressed surprise when told that Dow had been pumping waste into the ground in Sarnia until last October.

Griff Sherbin, who has been preparing a study of sediments in the St. Clair River offshore from the chemical industry, said "we were led to believe that no deep well disposal was going on" since 1976.

The Ontario Environment Ministry passed regulations in 1976 that ended the injection of wastes into the 16 area wells, according to its unreleased report, because chemicals from the injection wells came up to the surface behind a movie theatre in Sarnia and in downtown Port Huron, Mich.

Dow was allowed to continue to use the salt cavern because the regulation applied only to the wells into the shallower Detroit River formation and because the company assured the ministry that it was pumping the waste into the salt cavern only for storage and not for disposal, said James Dochstader, the head of the ministry's Sarnia office.

"Our obvious question of Dow is, 'OK, fine, now let's sit down and talk about how we're going to recover what's in that salt cavern' " so it can be disposed of in an appropriate manner, Mr. Dochstader said in a telephone interview yesterday.

However, Steven Bolt, an environmental officer with Dow, said he was not sure the technology exists to recover the hazardous waste from the old cavern if tests proved it was leaking.

If Dow now says it cannot recover the waste, then it was not "very honest with us because all the way along it was talked about as a storage cavern," Mr. Dochstader said.

At this point, governments and industry have different views on the source of the chemicals polluting the river that divides Ontario from the State of Michigan.

Federal scientists increasingly suspect leaking old injection wells are releasing chemicals through fractures in the bedrock in the river and these substances are combining with freshly spilled material to form the oily glob.

However, Ontario officials and an industry lobby group called the Lambton Industrial Society say the glob is being released from chemicals dumped years ago and trapped in sediments on the river bottom.

The source of relatively high levels of dioxins and furans is an even greater mystery for all parties because no industries in the chemical valley around Sarnia are known to have made chemicals that produce dioxins and furans as unwanted byproducts.

Ontario Environment Minister James Bradley told the Legislature yesterday that he has "not ruled out any of the (possible sources) and all the possibilities (will) be investigated."

NATIONAL EDITION

The Globe and Mail

142nd YEAR, NO. 42,409 ▪ CANADA'S NATIONAL NEWSPAPER ▪ THURSDAY, NOVEMBER 7, 1985

Toxic blobs called precursor of worst environment problem

BY JOCK FERGUSON
The Globe and Mail

Highly toxic chemical blobs found in the St. Clair River may be the precursor of the worst environmental problem seen in North America, according to a scientist at Environment Canada.

Eight billion litres of toxic chemical wastes were pumped under pressure into 16 underground wells by industries in the chemical valley in Sarnia, Ont., between 1958 and 1976.

If the wastes are leaking into the river, they could create the "biggest hazardous-waste problem ever in North America," said Daryl Cowell, an underground-water-movement specialist for Environment Canada.

Two other gravity-fed wells, used by Dow Chemical Canada Inc., operated at a much greater depth — 590 metres — and poured more than 41 million litres of toxic wastes into a large salt cavern until October 1984.

The wastes pumped down there are similar to those which showed up in the blobs, found in 1984 and 1985 on the river bottom, but Dow says its cavern is not leaking.

At the moment, occasional industrial spills, leaking waste pipes, sediment pollution and the possible upward migration of the well wastes are being examined to determine where the blob contamination originated.

Ontario Environment Minister James Bradley said he had instructed his officials to explore all possible sources of contamination, particularly the possibility that the old waste wells are leaking.

Most of the wastes are in a zone of porous rock called the Detroit River formation, and university scientists think more studies should be done to see whether water migrating upward to the river may have been contaminated by the underground wastes.

A probe by Ontario Environment Ministry investigators of enforcement and monitoring practices in the Sarnia area will be broadened to include an examination of when local ministry officials first knew that the old waste wells might be leaking.

In 1967, water in several wells in Port Huron, Mich., was found to be contaminated with phenols and hydrogen sulphide. In 1972, an abandoned 44-metre-deep well behind the Capitol Theatre in Sarnia was found to have greenish liquid containing

MINISTRY — Page A2

Ministry waste probe to be broadened

● From Page One

phenols, chlorides, hydrogen sulphide and organic carbon.

Both industry and local ministry officials have played down the latest blob findings, saying the material is from old wastes dumped in the river at least 10 years ago.

However, a theory some scientists are examining is that the underground rock and salt formations containing the wastes could be riddled with naturally occurring caverns, faults and underground rivers that could transport the wastes through rock fractures and eventually into the river.

Scientists with the Government and the University of Windsor caution that their work is only preliminary and a six-week Environment Canada study, announced last Friday by federal Environment Minister Thomas McMillan is designed to help identify the relative contributions of all possible sources.

If the wastes, which contain extremely toxic dioxins and furans, have spread widely, the cost of a cleanup could be vastly more than any other previously attempted cleanup, Mr. Cowell said.

"Costs could be an order of magnitude larger than the (more than $100-million) cost of cleaning up several of the worst (chemical waste) dumps in Niagara Falls, N. Y.," Mr. Cowell said in an interview yesterday.

No government is going to be able to tolerate the long-term contamination of drinking-water supplies for communities in both Ontario and the State of Michigan, so removing the wastes from the old wells could become a necessity, according to discussions with several academics and Government scientists.

This week, Mr. Bradley announced weekly testing of treated drinking water in five communities that draw their water from the river.

Many of the cancer-causing chemicals in the blobs have been detected in the raw water in communities downriver from Sarnia, but not in the treated water.

Most of the recent work on the St. Clair River is being done by scientists at the University of Windsor's Great Lakes Institute. Two of its studies have found indications that material may be coming up into the sediments on the river bottom.

Divers working for the institute found large dioxin-contaminated oily blobs of chemicals just above the river bottom in front of the Dow plant in August, 1984, and again in September, 1985. In both cases divers found indications that water, which could include some of the chemicals, was bubbling up through the river bottom.

Institute scientists have just published another study that shows a Dow waste product, octachlorostyrene, in high concentration in clams in the northeast section of Lake St. Clair.

The peculiarity of the high concentration has scientists wondering whether the waste may have come up through a water source coming into the lake bottom rather than down the river from Dow's plant, Mr. Cowell said.

In Ottawa yesterday, Mr. McMillan promised to investigate the possibility that dioxins in the St. Clair River between Ontario and Michigan originated in the United States.

Essex-Windsor New Democrat MP, Steven Langdon, asked the minister to investigate whether Dow Chemical of Midland, Mich., could have trucked waste contaminated with dioxin to Sarnia for disposal in Dow's salt cavern.

On Tuesday, a Dow Canada official said the company had not put any dioxin-contaminated waste material into its salt cavern and had not trucked any wastes from its Midland plant to Sarnia.

Attachment C

Natural Resources Defense Council, Inc.
122 EAST 42ND STREET
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415 421-6561

November 1, 1984

Mr. Donald J. Guinard
Chief, Water Supply Branch
Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365

Dear Mr. Guinard:

EPA has proposed to exempt a portion of the Knox Aquifer System from classification as an underground source of drinking water (USDW) so that three industrials facilities located near New Johnsonville and Mount Pleasant, Tennessee can continue to inject highly toxic and corrosive waste fluids into the drinking water aquifer. The Natural Resources Defense Council (NRDC), a non-profit environmental organization of over 40,000 members nationwide, feels compelled to comment on this proposal as it is the first of its kind and in its reliance on hopelessly inadequate evidence, could set a very dangerous precedent for future exemptions.

NRDC has monitored the Environmental Protection Agency's (EPA) Underground Injection Control (UIC) program since 1981, has worked toward a complete ban of all hazardous waste injection operations into and above drinking water aquifers, and has questioned any and all exemptions from this inherently sensible and long overdue prohibition. Unfortunately, the instant proposal confirms our very worst suspicions about the misuse of the exemption rule and represents the gravest threat to the protection of our limited underground water resources.

"The Knox Aquifer System in the vicinity of the facilities contains a sufficient quantity of groundwater to supply a public water system and contains fewer than 10,000 mg/l total dissolved solids." Therefore, in fulfilling the classification criteria, "the entire aquifer system is considered a USDW, even though the lower portion is not currently being used for drinking water supplies."[1] Industrial wastes are being injected into the Lower Knox in New Johnsonville by the E.I. DuPont de Nemours Co. and in

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[1] Aquifer Exemption Proposal for the State of Tennessee. July 30, 1984, p. 1.

New England Office: 850 BOSTON POST ROAD • SUDBURY, MA. 01776 • 617 237-0472
Public Lands Institute: 1720 RACE STREET • DENVER, CO. 80206 • 303 377-9740

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Mount Pleasant by the Stauffer Chemical Company and the Rhone-Poulenc Chemical Company. Such injection into a drinking water aquifer was banned as of June 25, 1984 and therefore must cease unless the aquifer is exempted.[2]

The criteria the EPA is using to justify the proposed exemption in the Knox Aquifer case, found at 40 CFR §146.4(a) and (b)(3), reads as follows:

- 40 CFR §146.4(a) - It (the aquifer) does not currently serve as a source of drinking water; and
- 40 CFR §146.4(b) and (b)(3) - It cannot now and will not in the future serve as a source of drinking water because it is so contaminated that it would be economically or technologically inpractical to render that water fit for human consumption.

Leaving aside, for now, the question of EPA's authority under the Safe Drinking Water Act (SDWA) to grant such exemptions, we find that the Agency's exemption proposal does not satisfy the Agency's own criteria. It is based on weak, insubstantial evidence and fails to address numerous significant questions. We shall elaborate on these shortcomings using the following examples.

Existence of a Confining Zone

The Agency argues that an impermeable zone exists that serves to confine waste effluents in the Middle and Lower Knox Group, isolating them from the Upper Knox Group that is presently used for drinking water supply. However, this conclusion is based only on a few available core data and an analysis of geophysical logs. Moreover, the very company that stands to benefit from the exemption, Rhone-Poulenc, states in its permit application Fact Sheet that "water quality samples from drill stem tests in the Rhone-Poulenc well indicates the recharge of fresh water has reached the lower portion of the Knox Aquifer."[3] Further discounting EPA's argument is the following statement by Michael Bradley, USGS, in comments to Albert Bates, Natural Rights Center, Summertown, Tennessee, August 8, 1984:

> "Water quality within the Knox does not increase or decrease with depth, but rather is characterized by unpredictable zones of varying quality. At the lowest reaches below 5,000 feet, water with TDS content of less than 500 mg/l has been verified."

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[2] 49 Fed. Reg. 20141 (May 11, 1984).

[3] Fact Sheet, Underground Injection Control Permit Application No. TN10001, Revised Aug. 2, 1984, p. 6.

For such pure water to be found at such depths, communicating pathways to the surface must be observed.

Also, there is some indication that migration to surface waters from the deep wells may in fact be occurring, either from fractures in the confining layer, abandoned well bore(s),[4] or inadequate seals in the injection piping. The evidence of migration derives from data assembled by the Stauffer Chemical Laboratory and from Stauffer Chemical Co. submissions to the Tennessee Water Quality Control division. A freshwater on-site spring was sampled daily for trace quantities of benzene and nitrometacresol, two components of the injection wastewater. The data was analyzed by Dr. Barbara Wallace of the Ethos Research Group in 1982, who discovered correlations between concentrations of benzene and nitrometacresol in the spring water and activities of Stauffer Injection Well #3. (See attached Figures A and B). While the correlations are suggestive and not conclusive (the effects could be explained by other causes), the possibility of waste migration from Well #3 to the on-site spring cannot be discounted.

The Agency has not only provided little evidence to support its claim of inpenetrable confining layers, but it also has not demonstrated that at pressure limits it proposes to set for the injection operations, 500 psig, fissures will not form in the confining layer. One's frustration with such disregard is compounded by the fact that the epicenters of two earthquakes that occurred in 1843 and 1928 were determined to be in or near Maury County,[5] where the Rhone-Poulenc Facility is situated, and that therefore considerable earth movement has occurred and could occur again some time in the future. The Agency does not even have a plan for detecting such fracturing or a response strategy if it were to occur. It's worth noting that enormous sums are spent to study the capacity for different leachates to pass through landfill liners and yet we have devoted virtually nothing to the study of how wastes injected under pressure will affect or behave in the sub-surface. Landfills now handle only three percent of the hazardous wastes being disposed, injection wells handle close to sixty. Why this imbalance? Have we really a good reason to be so self-confident?

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[4] "According to the State Geologist, thousands of boreholes were drilled in middle Tennessee during the 1960s in search of zinc deposits. Many of these penetrated the Knox dolomite. Many of these boreholes were abandoned leaving vertical open conduits a few inches in diameter extending from a few feet below the land surface to depths of several thousand feet. Moreover, the locations and depths of these open conduits are not recorded." (Report of the Tennessee Groundwater Protection Strategy Task Force on Regulation of Subsurface Wastewater Injection by Means of Wells. Jan. 7, 1982, pp.13-15).

[5] Statement of Dick Sterns, Professor of Geology at Vanderbilt University at Public Meeting, Centerville, Tenn., October 25, 1984.

Extent of Contamination

To satisfy the requirements of 40 CFR §146.4(b)(3) on the extent and severity of contamination, the Agency merely gives a description of the waste stream. It makes no attempt to determine the areal extent of contamination or the concentrations of contaminants in the injection zone. Maybe some contaminants have dispersed, broken down, or been adsorbed. Maybe not. In any case, the Agency has done very little to substantiate its claim that contamination is so severe it could not be remedied.

In addition, the Agency makes little attempt to analyze the cost and effectiveness of restoring the contaminated groundwater in the proposed zone of exemption, an important factor in substantiating a claim that irreparable damage has been done. In fact, EPA undercuts its own argument in its economic analysis, by assuming essentially the same level of water treatment and therefore the same costs for water drawn from wells penetrating the Knox Aquifer System as from the present water supply. This certainly would not be the case if the Knox Aquifer was grossly contaminated. Consequently, if any conclusion can be drawn on this matter it is that the information EPA provides in the proposal is so hopelessly inadequate that one cannot even begin to make a meaningful statement on the extent and severity of the contamination in the Lower Knox or, if necessary, the ability to restore it for drinking purposes.

Ironically, the Agency is hoping to demonstrate on the one hand, that these wastes are so highly toxic as to have irreparably damaged the Lower Knox Aquifer while, on the other hand, are not so toxic as to necessitate their being labelled hazardous waste.[6] Which are we to believe? The Agency can't have it both ways, particularly as it has not provided any evidence to adequately support either claim.

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[6] None of the waste streams are now considered hazardous waste. The DuPont waste, mining waste, is exempted by Congress, despite its strong acidity (0.5-1.5 pH). The Stauffer and Rhone-Poulenc waste streams, result from the production of pesticides, were hazardous wastes until they were temporarily delisted this year without notice or comment. The basis of these delistings and many others like them is that the waste streams come up negative in the E.P. toxicity test, i.e., they do not contain the toxic substances which the test can identify. Of course, the E.P. toxicity test is unable to test for organics, so many waste streams containing highly toxic organics will be falsely classified as non-toxic. However, the State Biology Section, upon examination of the Rhone-Poulenc waste stream, concluded: "The toxicity derived from this study indicates that the effluents under study are quite toxic, both acutely and chronically." (Michael Higgs, et al., Toxic and Mutagenic Properties of Chemical Effluents Being Injected into Deep Wells. Biology Section, Division of Water Quality Control, Tenn. Dept. of Public Health, Nashville, Aug. 1, 1980).

Calculated Exempted Area

At the present time, the true areal extent of contamination is completely unknown and is impossible to derive or accurately predict without more data. The Agency, however, attempts to derive the proposed exempted area for the Dupont and Stauffer wells based on only two data points at each site, an operating injection well and a newly drilled well, which happened to intercept the waste fluids. While the Agency acknowledges that, without knowing the full extent of contamination, it must be assumed that the distance between the two points can only represent the minimum distance the waste has travelled, it does not hold to this notion when providing an adequate margin of safety. Indeed, EPA shows very poor judgment in this calculation.

Let us take for example the EPA calculation at the DuPont facility. Based on a distance between the operating Well #3 and the newly drilled Well #5 of 3,300 feet and a 30-month interval between injection at Well #3 and sampling at Well #5, a minimum rate at which the waste moved of 110 ft./mo. or 3.6 ft./day is calculated. Based on this minimum flow rate, after 30 years of injection operation, the minimum projected distance of waste migration is 7.5 miles. The EPA, assuming some dispersion and dilution, added a mere 1/2 mile safety factor and selected a radius of 8 miles as the exempted areas.[7]

What does this mean? It means that EPA completely ignored the fact that this was a minimum rate. Indeed, if the contaminants moved a mere 3 1/2 inches more a day than the calculated rate of 3.6 ft./day, they would migrate beyond the exemption area in the 30-year period of operation and contaminate non-exempted portions of the Knox Aquifer System. A difference of 3 1/2 inches a day is insignificant when dealing with such highly simplified estimations as EPA is using here. Nor would it be influenced by the effects of dispersion or dilution.

At the Stauffer and Phone-Poulenc facilities,[8] where the wastes were estimated to travel, at a minimum, a distance of 1.06 miles in 30 years or 15.6 ft./month,[9] the wastes would need to move only 2 1/2 inches a day more than the calculated minimum to migrate beyond the 1.5 mile (radius) exempted area in 30 years. Again 2 1/2 inches is insignificant in such a simplified analysis.

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[7] Aquifer Exemption Proposal, p. 26.

[8] In the absence of two points with which to perform its calculations, the Agency assumed similar conditions at the Rhone-Poulenc facility as were calculated at Stauffer.

[9] Aquifer Exemption Proposal, p. 27.

Furthermore, there is no indication that the Agency performed any tests to determine the integrity of the confining layer at the 7.5 mile circumference around DuPont or the 1.06 mile circumferences around Stauffer or Rhone-Poulenc. Nor has EPA discussed the potential for additive or synergistic effects associated with the combined injection pressures at the Stauffer and Rhone-Poulenc facilities, whose exemption areas almost overlap.

Given the likelihood that the wastes would migrate beyond the exempted areas, more of the aquifer would be contaminated and eligible for exemption. Following the faulty approach in the instant proposal, exemptions could be considered for increasingly larger portions of the aquifer.

Economic Analysis

The Agency performed a simple economic analysis to determine if the lower portion of the Knox could be used as a practical source of drinking water. "The analysis concluded that it would not be practical to use the lower portion of the Knox as a source of drinking water, because the existing water sources for the Mt. Pleasant area are adequate to supply the existing and projected population's water supply needs."[10]

However, EPA's analysis considered only a 16 year period form 1984-2000. Moreover, it did not take into account a Corps of Engineers determinaton that Maury County will experience an acute water need within the next 50 years and that the proposed Normandy Dam will be unable to supply this need.[11] Ironically, the acute water need in the area is the principal justification for the Normandy Dam.

In addition, EPA did not consider the increasing number of incidences of drinking water contamination within the shallow groundwater supplies which could force people to seek deeper supplies. The Stauffer Chemical Company has already contaminated local wells of nearby landowners.[12] Also Stauffer's first injection well failed when casing collapsed at a depth of approximately 2,930 feet in 1975. Ninety feet of casing was determined to be in poor condition or ruptured. For an unknown period of time, Well #1 operated with an uncontrolled discharge into the Upper Knox. Dupont's Well #2 also injected into the Upper Knox at 2,350 feet. EPA moved the exemption level for

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[10] Statement of Gail Mitchell, EPA Hydrogeologist found in transcript of hearing on UIC permit and Rhone-Poulenc Exemption, August 8, 1984.

[11] Comment of the Natural Rights Center, et al., in the matter of Underground Injection Control Permit No. TN10001 and Aquifer Exemptions for the State of Tennessee. September 7, 1984, p. 16.

[12] Id., p. 17.

DuPont higher to compensate.[13] There is no guarantee that these wastes will not migrate into existing sources of drinking water, making drilling into deeper supplies a necessity.

Conclusion

Without more compelling evidence, the Knox Aquifer exemption proposal for continued injection operations represents one of the more blatant attempts to discount our deeper underground water supplies in the name of short-term gain. If approved, this first proposal for hazardous waste injection purposes would set a precedent for exempting aquifers from the protection provided them under the SDWA based on little more than the present use of the aquifer as a drinking water source and the existence of operating injection wells. The result would be a complete subversion of the preventive intent of the SDWA. Should an exemption be made on such weak evidence, we may feel compelled to consider legal recourse.

Sincerely,

Wendy Gordon

Wendy Gordon
Science Associate

Jane Bloom, Esq

Jane Bloom
Senior Project Attorney

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[13] *Id*, p. 17.

ATTACHMENT

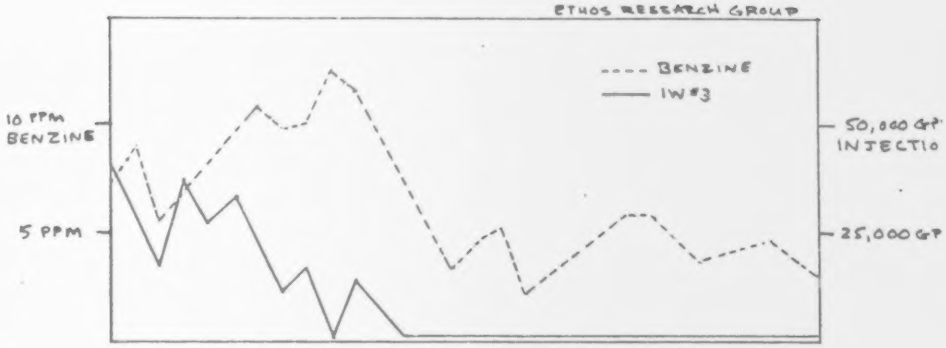

FIGURE A. BENZINE IN SPRINGWATER AND DEEP WELL INJECTION FOR JULY, 1980.

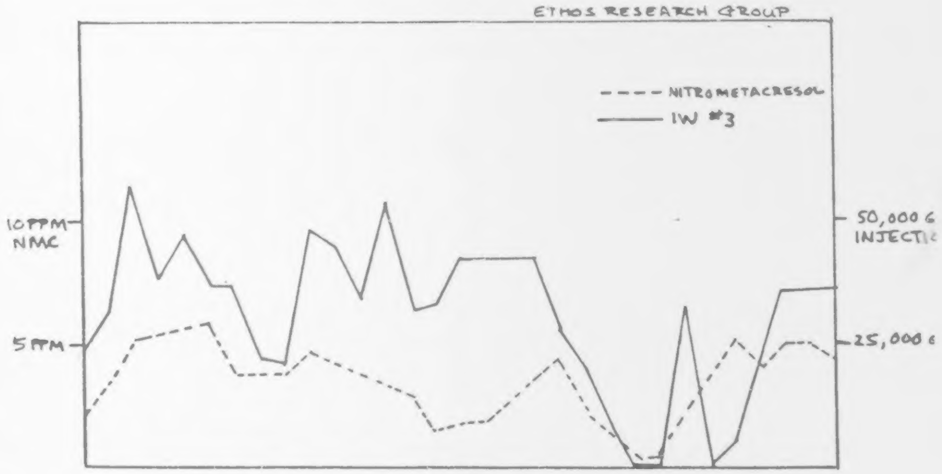

FIGURE B. NITROMETACRESOL IN SPRINGWATER AND DEEP WELL INJECTION FOR OCTOBER, 1980.

Testimony for Al Giese
for The Fertilizer Institute
before
Subcommittee on Toxic Substances and
Oversight of Senate Committee on
Environment and Public Works

Mr. Chairman, my name is Al Giese and I am Vice President, Agronomy Division, Land O'Lakes, Inc. in Minneapolis, Minnesota. I am here today on behalf of The Fertilizer Institute (TFI)*. I am Chairman of the Institute's Water Quality Work Group.

The fertilizer industry shares your concern about groundwater quality, and we commend you for holding these hearings. We realize it is a vital natural resource, serving as a source of drinking water for more than half of our population and a source of irrigation water for much of our food production in the U.S. We in the fertilizer industry also are concerned about groundwater quality and issues relating to it. We fully recognize that we provide American farmers with a major source of plant nutrients for providing high soil fertility, which in turn accounts for highly productive crop yields.

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*TFI is a voluntary, non-profit association whose members represent approximately 95 percent of the domestic fertilizer production in the United States. TFI's membership includes: producers, manufacturers, traders, retail dealers and distributors of fertilizer materials. Its members are major shippers, receivers, and exporters of fertilizer and fertilizer materials and are a vital link in the nation's agriculture system.

Nutrients and Food Production

American agriculture is very dependent upon the use of fertilizers for maintaining soil productivity. USDA estimates that fertilizer use accounts for approximately one-third of our total crop production. In many instances, however, per-acre yields of some key grain crops would be half of what they are today without fertilizers. If we take corn, for example, a 150 bushel per acre crop** has a requirement of over 500 pounds of plant nutrients. A farmer can produce such a yield only if these nutrients are available in the soil, whether they come from commercial fertilizers, soil itself, or other sources such as manures. Thus, commercial fertilizers are only one source of nutrients for crop production.

Nutrients in fertilizers are the basic building blocks for life. We can harvest protein in our crops only if there is nitrogen provided for the plant. Likewise, we can harvest phosphorus and the other mineral elements only if they are available for plant growth. Without nutrient elements, such as phosphorus and calcium, humans would soon come up short on teeth and bones. Thus, commercial fertilizers are a major source of nutrients, not only for crop production, but for the food we consume. It may seem very basic, but all of us in this hearing room today depend on about 12 grams of nitrogen and one gram of phosphorus in our daily diets to meet our nutritional requirements.

**The Fertilizer Handbook, The Fertilizer Institute, 1982.

Some Facts on Nitrogen

Since the subject of today's hearing is groundwater, I shall limit my comments to nitrogen. Of the nutrients supplied in fertilizers, it is the only one that is sufficiently soluble to be mobile in groundwater. Phosphorus, very unlike nitrogen, reacts very quickly with soil constituents and reverts to insoluble forms. With only rare exceptions is it mobile in groundwater. Essentially the same applies to potassium and other nutrients in commercial fertilizers.

Nitrogen, on the other hand, is very dynamic. Agronomists have long referred to the wide-range of nitrogen forms, and their constant interchange, as the "nitrogen cycle." The entire nitrogen cycle encompasses air, soil, surface water and groundwater. In a sense, we live in a nitrogen environment, with the air we breathe being 75 percent of this element. Air over each acre of the earth's surface has approximately 35,000 tons of nitrogen, but this is useless for plant growth until converted into forms plants can use.

In this "nitrogen cycle" it is important to realize that plants can absorb from the soil only two forms of nitrogen - nitrate and ammonium nitrogen. Of these two forms, nitrate is the mobile form, but ammonium nitrogen is quickly oxidized by bacteria in the soil to nitrate, so even ammonium nitrogen can become mobile as it is transformed to nitrate. For an authoritative reference on nitrogen and its role in crop production, I would like to enter into the hearing record a recent monograph on the subject, entitled Nitrogen and Crop Production. This excellent reference contains extensive detailed information of the numerous issues of nitrogen use in food production and its fate in the environment.

Table 1 lists information The Fertilizer Institute presented in a recent conference, "Plant Nutrient Use and the Environment," which illustrates the magnitude of nitrogen in the environment available for food production.

Table 1

Major Sources of Nitrogen on 360 Million Acres in Crop Production

	Million Tons N/Year
Precipitation[a]	1.8
Legumes [b]	6.3
Soil[c]	9.0
Fertilizers	11.0
TOTAL	28.1

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a/ 10 lb N/a/yr on 360 million acres
b/ Phillips and Delong in Nitrogen in Crop Production
c/ 50 lb N/a/yr on 360 million acres

As the above table shows, of the 28 million tons of nitrogen available for food production on 360 million U.S. acres approximately 39 percent comes from commercial fertilizers. Based on U.S. Department of Agriculture figures for 1984 provided in Table 2 below, the weighted average application rate of nitrogen application from fertilizers is 75 pounds of N per acre for major crops.

Table 2

Nitrogen Fertilizer Application Rates Per Acre on Major U.S. Crops in 1984[a]

Crop	Pounds N/Acre	Million Acres Planted
Soybeans	17	67.8
Wheat	58	79.2
Cotton	72	11.1
Sorghum	130[b]	17.2
Corn	130	80.4

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a/ U.S. Department of Agriculture, Fertilizer Outlook and Situation, 1984.
b/ Assumed to be same as for corn.

Obviously, there are very large quantities of nitrogen in the environment, but it is those quantities that plants can use for producing protein in which we are most interested.

With a daily consumption of 75 grams of protein per person, the daily nitrogen intake is 12 grams of nitrogen. (Protein is typically 16 percent nitrogen.) Over a year's time, this nitrogen intake in the food chain in the U.S. represents 1.1 million tons. This figure, when compared with the figure of 28 million tons of total nitrogen that is available for crop production, illustrates a ratio of only one pound of nitrogen consumed in the food chain for each 25 pounds of nitrogen available as inputs.

Such numbers illustrate the inefficiencies of the modern agricultural system, which still has some severe limitations imposed by nature. Despite the tremendous strides made for improved efficiency, we still depend upon plants whose best root systems occupy only about 1 percent of the soil volume, and plants that use 400-500 pounds of water per pound of dry matter produced. These are some of the basic conditions we face with food production in our current natural system of soils, water, air and sunlight energy. Obviously, the system is not leak-proof and, with an element as versatile and as mobile as nitrogen, it surely will be present in varying degrees in nature's universal solvent, water.

Another fact that we as food consumers, whether as producers of commercial fertilizers or producers of federal legislation, must realize is that there is no complete recovery of applied nitrogen by the crop to which it is applied. Major grain crops typically recover 50-70 percent of the applied nitrogen. For those who want spinach and lettuce in vegetable salads, and for those who want strawberries in their ice cream, there is the bad news that such plants, with very limited root systems, seldom recover much more than about 20-25 percent of the applied nitrogen. Thus, as long as we want to produce the foods of our current preference, there will continue to be large requirements of nitrogen for the production of these crops. Moreover, there will continue to be losses to the environment until a molecular biologist or a geneticist comes up with plants that do a much better job in recovering nutrients from the soil.

Industry as an Advocate of Judicious Fertilizer Use

The leadership of the U.S. fertilizer industry has faced these facts and others regarding the use of nutrients supplied in commercial fertilizers for food production and their fate in the environment. It consequently has taken the initiative in a variety of positive programs to encourage practices that minimize losses of applied nutrients to the environment.

For decades, the fertilizer industry has been a strong advocate of soil testing as a diagnostic tool for determining optimum rates of nutrient applications to match specific needs of soils and crops. We have had a long and consistent record of supporting soil testing as a diagnostic tool for farmers to use in improving their management of nutrients in crop production.

More recently, The Fertilizer Institute's Board of Directors passed a resolution in 1983 formally urging judicious application of nutrients on land through the use of soil tests and careful consideration of soil type and crop conditions and, thereby, reducing losses to surface and ground water. Soil testing has been one of the foremost Best Management Practices (BMP) for plant nutrient use.

In issues of the bimonthly magazine, Fertilizer PROGRESS, The Fertilizer Institute has published 9 articles featuring BMPs for crop production. This magazine has a circulation of approximately 30,000 -- most of whom are retailers providing management and product service to the nation's farmers.

Additionally, a special publication in 1984 of the Institute, Clean Water, has had considerable attention in the past two years. This publication not only identifies some of the sources of nutrient losses to the environment, but also identifies actions by farmers which the fertilizer industry encourages in order to promote efficient use of fertilizer and reduce nutrient loss to the environment. The Institute has distributed more than 20,000 copies of this brochure in the past two years, and a like number of magazine article reprints. I would like to enter a copy of TFI's brochure in the hearing recored.

And, most recently, the Institute sponsored in October 1985 a symposium on "Plant Nutrient Use and The Environment." I would like to enter a copy of the proceedings for that symposium in the hearing record. It is a compilation of 16 authoritative assessments of plant nutrient use in agriculture and the fate of these nutrients in our environment.

The Agronomy Division of Land O'Lakes, which I manage, is a leading marketer of fertilizer to upper midwestern member cooperative retail dealers who provide products and associated services to their farmer members.

The Agronomy Division offers several programs that provide the proper training and technical knowledge to our dealers and their farmer customers to ensure that all products marketed by Land O'Lakes are used efficiently and in a safe manner from both a human and environmental standpoint.

The leading program is called "The Croplan Agronomist Program," which positions each of our member dealers with a professionally trained agronomist to assist farmers with their crop production decisions. This agronomist is supported with the latest technical information, computer systems, regulatory requirements, and on-going training to ensure that the products Land O'Lakes markets are used safely and efficiently. The Agronomy Division maintains a fully staffed department of trained professionals to constantly stay abreast of new developments and provide on-going training to the agronomists.

In addition, Land O'Lakes conducts extensive research with products it markets at the Land O'Lakes research farm called "Answer Farm," located in north central Iowa. Several nitrogen research projects are conducted on both a short term and long term basis at the Answer Farm. To mention two of these research trials: Number one would be the evaluation of fertilizer placement and tillage interaction with various sources of nitrogen and tillage practices; another would be nitrogen uptake comparisons by corn varieties. This trial is to evaluate how different corn varieties utilize nitrogen during their growth.

Currently, well over 200 professionally trained agronomists are represented by this system in the seven upper midwestern states in which Land O'Lakes markets, and the program is rapidly expanding.

Recommendations

I would stress that evidence currently available shows that, as long as we will be the beneficiaries of abundant and nutritious food made possible through fertile, productive soils, there will be some losses of nutrients -- regardless of source -- to the environment. Clearly, agriculture and the industry serving it have a responsibility to minimize these losses -- while at the same time utilizing practices that maximize recovery of nutrients in the soil.

Some suggestions as to where we should go in the future are included in a recent report by EPA, "Review of the EPA Groundwater

Research Program," July 1985. This report describes the wide array of six current federal laws and their jurisdiction with regard to groundwater. They range from the Safe Drinking Water Act to the Clean Water Act. The EPA report points to the need for improved coordination of research, and even suggests allocation of some Superfund dollars exclusively for research. This EPA study also identifies possible problems resulting from the land itself being used as a depository for a variety of wastes. Further, the report suggests the need for more research in the basic processes that govern the transport and fate of contaminants in groundwater.

After reviewing such reports and making an assessment of the issues related to plant nutrient use and groundwater quality, we would submit the following:

1. There is an abundance of information currently available for improving recovery of nutrients applied for crop production and, hence, cutting losses to the environment.
2. Informed management decisions by individual farmers -- taking into account their local climatic, cropping and soil conditions -- will be the best means of minimizing nutrient losses to the environment.
3. Heterogeneity, not homogeneity, is the rule in regards to groundwater issues as related to agriculture. Even in a single state, there are extremely wide ranges of conditions of not only precipitation but geology and soil conditions that affect not only the quantitites of elements, such as nitrate, entering groundwater but also greatly affecting the rate at which these quantities may be transported within the soil. We simply see no way any single piece of legislation could address the nearly infinite number of combinations of conditions to best manage nutrients in the environment.

4. There is a wide array of federal research efforts underway to study groundwater. Designating a primary responsibility among the federal agencies, such as with USDA's research arm, the Agricultural Research Service, could improve the rate at which we will increase our knowledge of not only how agriculture and other activities are impacting groundwater, but also in identifying practices in agriculture that will minimize nutrient losses.

5. Some judgment should be made as to whether EPA, the U.S. Geological Survey or some other federal body should have the responsibility of establishing guidelines for classifying groundwater sources according to quality that in turn would be useful to states as they administer their laws tailored to local conditions.

All of us in this room share in our national goal of preserving and protecting America's natural resources -- one of the most precious of those being our water supplies. Our industry and the farmers we serve are all people, too. We have children and grandchildren and future generations for which we seek the same goals of natural resource preservation.

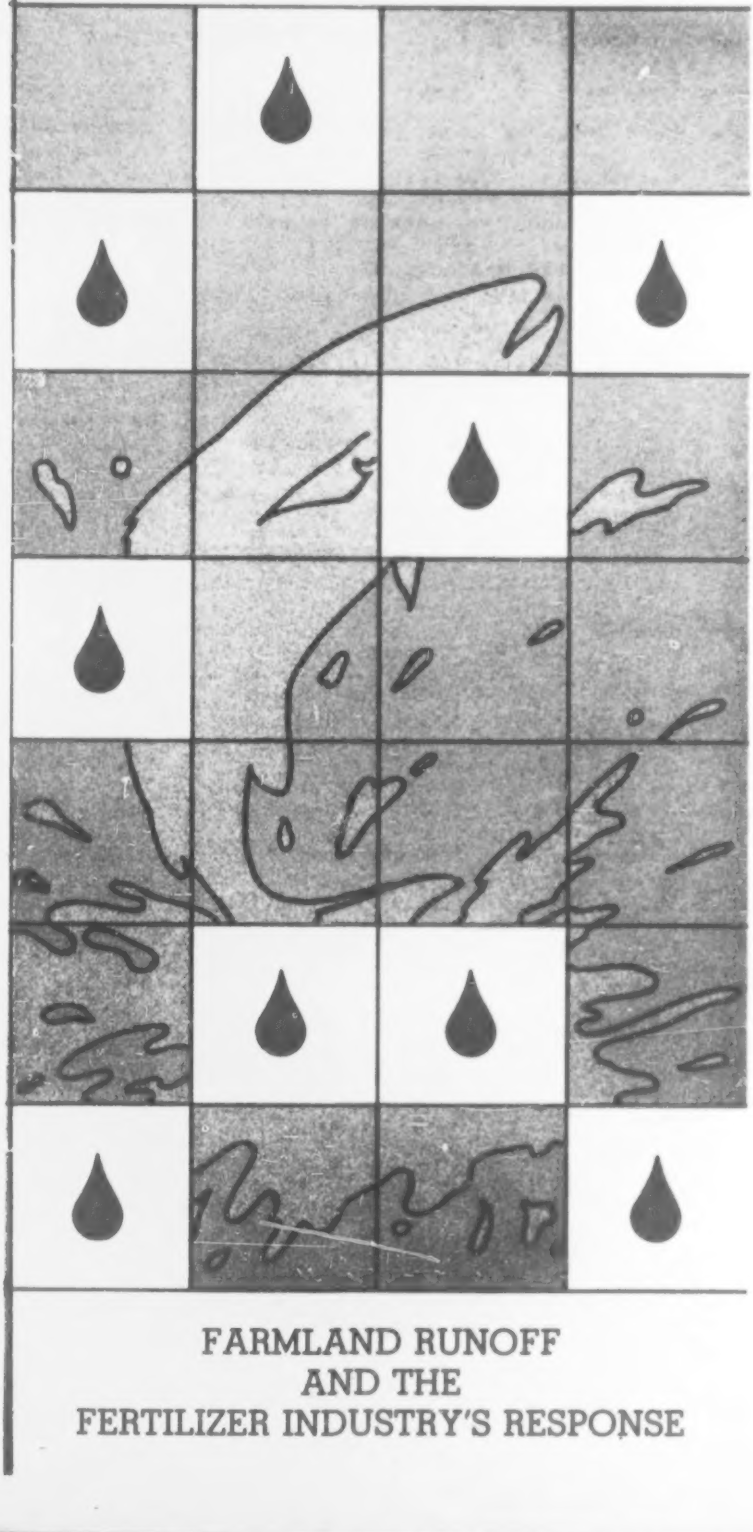
As we seek such ideals, we need to focus on a rational formula which achieves our ends -- not one which renders judgments that have yet to be verified, and could actually reduce the national heritage we seek to preserve.

I'm sure it would surprise many to learn that an alfalfa crop can add 100 to 150 pounds of nitrogen to the soil per acre per year, having drawn that nutrient from the air we breathe. And, soybeans, in a like manner, can add 60 to 100 pounds nitrogen per acre to the soil. Yet, should we suggest a moratorium on plantings of soybeans and alfalfa in order to protect groundwater?

Farmers have an economic imperative of producing at peak efficiency. Consumers expect abundant food supplies at low costs. Both groups share concerns about the environment. Commercially applied nutrients satisfy the first two needs, and the industry which provides the product is working to exceed public expectations related to environmental protection.

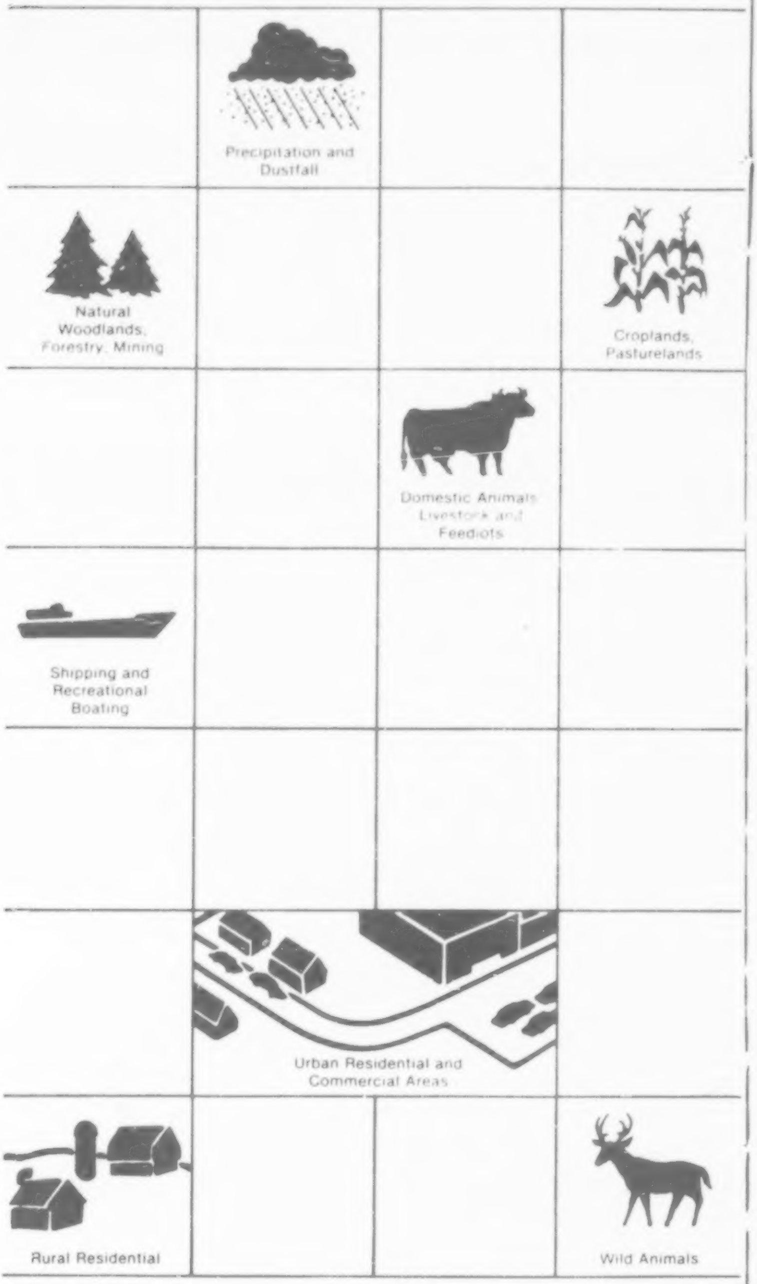
Let's work together. As always, we stand ready to act and respond.

An Agricultural Concern
CLEAN WATER



FARMLAND RUNOFF
AND THE
FERTILIZER INDUSTRY'S RESPONSE

Sources of Nonpoint Runoff


Precipitation and Dustfall
Natural Woodlands, Forestry, Mining
Croplands, Pasturelands
Domestic Animals: Livestock and Feedlots
Shipping and Recreational Boating
Urban Residential and Commercial Areas
Rural Residential
Wild Animals

A New Public Concern

Clean water is a goal that has become increasingly important in recent years as Americans have become more aware of how easily the quality of our water supplies can be downgraded by human activity.

Thanks to a cooperative program between federal, state and local governments, and coordinated efforts of industries and municipalities, pollutant discharges into the nation's surface and underground waters from "point sources" (pipes, drains, industrial and municipal wastewater sites) have been reduced.

But, there is a remaining challenge that is receiving increased public awareness—that of identifying and reducing runoff into waters from "nonpoint" sources. Such nonpoint inputs can be transported to lakes and streams by rainfall-initiated runoff from urban and suburban areas, agricultural lands, forests, construction operations, and abandoned mine sites. Rainfall also carries with it atmospheric fallout.

The Challenge is Complex

"Nonpoint runoff" is a complex challenge because there is no accurate means to determine a single nonpoint source's contribution to overall runoff. Further, any estimates of runoff must consider specific area conditions like topography, climate, and land use. The illustration on the opposite page shows several possible contributors to nonpoint runoff.

All of these nonpont sources can carry plant nutrients, and excessive amounts of nutrients can cause stress in aquatic systems. This stress can result in stimulation of plant life, such as algae, which can contribute to the depletion of oxygen in waters and the decline of some forms of aquatic life.

Those in agriculture realize that plant nutrients must be conserved in soil—and the soil must remain on the field. Soil loss represents a financial loss to farmers, as well as to land resources. That is why farmers, and their input industries, support strong and workable soil conservation practices. Today, however, a new reason for keeping soil and plant nutrients in place is receiving attention—the potential impact of agricultural runoff on rivers, streams, lakes and groundwater supplies.

Agricultural runoff can come from the following:

- *Rangeland and pastureland*
  Overgrazing of range- and pasturelands often can lead to soil erosion and the added contribution of soil sediment and plant nutrients to water runoff.
- *Livestock facilities, such as feedlots*
  Livestock, allowed to graze freely along stream banks, can compact and damage them, thus increasing the soil erosion potential and stream sedimentation problems, as well as adding livestock wastes to streams. Uncontrolled runoff from barnyards and feedlots can carry organic matter, plant nutrients, fecal bacteria, and other micro-organisms.
- *Cropland*
  Nonirrigated croplands may contribute sediment, plant nutrients, and residual crop chemicals; irrigated farmland can be a source of these, as well as salts and other minerals left by irrigation.

Origins of plant nutrients to farmland can include:

- Soil
- Animal waste
- Natural plant decay
- Fertilizer
- Bacteria in the soil
- Precipitation
- Dustfall

The specific contribution of each source is extremely difficult to determine at any one location and will vary from area to area.

Farm-Promoted Solutions

Best management practices (BMPs) for reducing water runoff and soil erosion from farmland, including crop and land management practices, have been credited with reducing nutrient runoff. When erosion and runoff are reduced, so are plant nutrient losses.

Practices which reduce soil erosion and promote conservation, such as conservation tillage, soil testing, timing of fertilizer application, strip cropping, cover crops, terracing and buffer strips, are all highly effective in cutting losses of plant nutrients.

For years, the fertilizer industry has promoted the increased efficiency of fertilizer use and the reduction of nutrient loss by actions described in the chart on the following page.

Implementation of BMPs can increase soil productivity, lower the farmer's cost of crop production, improve crop production efficiency, and reduce losses of nutrients to the environment.

The fertilizer industry is continuing its effort to provide information to farmers and the public about the benefits of essential and judicious fertilizer application, coupled with soil conservation management practices. For example, a vigorous cover crop, with its more extensive canopy and root system, whether it be a forage crop, idled cropland, or productive row crop, affords protection against soil and nutrient losses. Such cover crops require adequate fertilization for their establishment and maintenance.

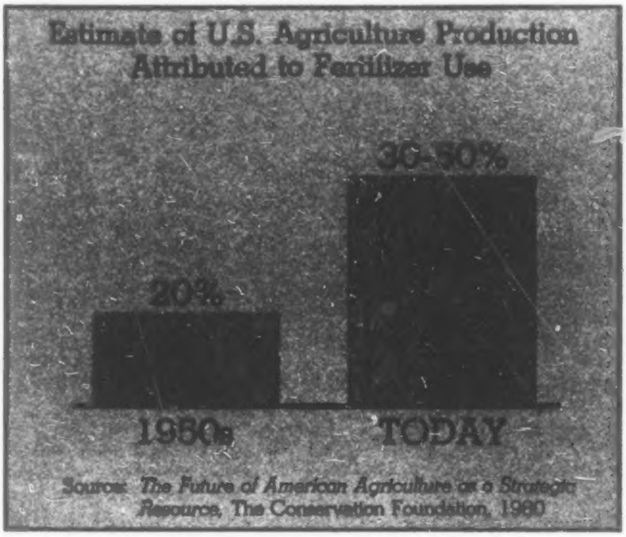
The future of essential crop production, farm production efficiency, and soil and nutrient conservation depends on the ability of our nation's farmers to expand their use of sound management practices. The fertilizer industry, therefore, supports and encourages the voluntary adoption of best management practices for agriculture.

Actions encouraged by the fertilizer industry to promote efficient use of fertilizer and to reduce nutrient loss

Action	Benefit to Reduce Nutrient Loss
Encouraging and providing soil testing services	State-of-the-art analysis of plant nutrients in the soil accurately prescribes amounts of fertilizer and lime required for optimum crop growth.
Developing new fertilizer products	Fertilizers that improve plant uptake of nutrients mean less residual nutrients that might be lost from soil.
Promoting proper application, timing and placement of fertilizer	Proper timing and placement of fertilizer application coincide with plant needs and reduce nutrient loss.
Developing fertilizer programs and methods for conservation tillage	Reduced soil tillage helps reduce runoff and erosion from cropland. Fertilizers best suited to those tillage practices are being studied.
Encouraging better cropping practices	Reduced soil erosion and better nutrient utilization results from the use of recommended cropping practices.
Promoting and encouraging plant tissue testing	Plant tissue tests help assess the amount of plant nutrients needed by the next crop for optimum growth.
Funding research and developing programs to obtain higher per-acre yields, and improved production efficiency	Higher per-acre yields are more profitable for farmers, and are more efficient in resource use. With higher yields, less land is required for producing a given quantity of food.

Commitment: A Needed Food Supply

The continued use of fertilizer is essential to achieve the levels of American crop production necessary to assure an abundant food supply for our nation . . . and for world markets supplied by American agriculture. Without fertilizer use, agricultural yields would be reduced catastrophically. Today, fully 30 to 50 percent of the food and fiber bounty produced by U.S. farmers is attributed to use of fertilizers.



Estimate of U.S. Agriculture Production Attributed to Fertilizer Use

Source: *The Future of American Agriculture as a Strategic Resource*, The Conservation Foundation, 1980

Fertilizer acts as a "land substitute," as well. Without fertilizer, additional cropland would be needed to meet today's demands for U.S. food and fiber production. Little additional land suitable for cropping exists in our nation. If we had to respond to an increased demand for land, farmers would have to call on the increased use of the nation's poorer, more erodible soils. Insufficient plant foliage cover of less vigorous crops also would increase the likelihood of soil erosion.

The fertilizer industry—a vital link in our nation's food chain—supports a close working relationship with our agricultural producers to promote a strong American agriculture. Sound, cost-efficient farming practices and voluntary adoption of soil and plant nutrient conservation practices are essential steps in achieving this goal.

NONPOINT SOURCE CONTAMINATION OF GROUNDWATER BY AGRICULTURAL CHEMICALS
(Technical Comments)

George R. Hallberg, Ph.D.
Chief, Geological Studies
Iowa Geological Survey
Iowa City, Iowa 52242

ABSTRACT

Research conducted in Iowa during the past five years has shown that nitrates and some pesticides are leaching through the soil into shallow groundwater and are now found in many of Iowa's groundwater aquifers. These groundwaters supply drinking water to both municipalities and private individuals and now commonly exhibit nitrate concentrations above the maximum contaminant limit for public drinking water. Poor waste-disposal practices contribute to individual problems and misuse of chemicals have caused severe problems locally. However, the regional contamination of groundwater is the result of conventional usage of ag-chemicals and constitutes a nonpoint source pollution problem.

Much of the research, and hence much of the attention to this problem, has been focused in northeast Iowa, particularly the Big Spring Basin. Such contamination, however, is clearly occurring throughout Iowa and the corn belt. Currently, this contamination is primarily found in relatively shallow aquifers, but this may only be a function of time.

The Iowa research has shown that regionally, in susceptible settings, nitrates in groundwater have increased in a direct, linear fashion, paralleling the increased use of N-fertilizers. Monitoring of the Big Spring Basin shows losses of NO_3-N in water equivalent to a minimum of 33% to 50% of the N-fertilizers applied. Experiment-farm studies suggest that only about 35% of the fertilizer applied is removed in corn grain. Such nitrogen losses have been built into our fertilizer-yield models without fully understanding the inefficiencies. Such losses constitute an economic, as well as an environmental problem. In Iowa alone farmers spend more than $400 million annually on N-fertilizers; when 50%-70% of that N is not going for grain production there is obvious room for economic gains.

Pesticides are being found in groundwater more extensively than anticipated, albeit in low concentrations. Losses of pesticides into water are generally less than 5%. Few long-term data exist, but Iowa studies suggest that pesticide residues in groundwater are likely increasing, perhaps analogous to the rise in nitrates of a decade ago.

As with all nonpoint source pollution the scope of the problem is large. For example, approximately 60% of the total land area of Iowa is in row-crop cultivation which receives ag-chemical applications. There are concerns for

Prepared for the United States Senate Committee on Environment and Public Works, Subcommittee on Toxic Substances and Environmental Oversight, The Honorable David Durenberger, Chairman. December 12, 1985.

public health, because of the potential for long-term and widespread exposure. The long-term implications of the coexistence of nitrates, pesticides, and other chemicals is unclear. Some epidemiologic studies suggest patterns of risk, but unfortunately epidemiologic proof often takes a generation of exposure.

The leaching of ag-chemicals to groundwater is occuring, in part, because we have not fully understood the movement and behavior of water and chemicals in the soil. That understanding is evolving, and we can take advantage of these processes to minimize losses. We must develop holistic approaches to ag-management, coupling our need for soil conservation, surface water protection, with groundwater protection as well.

Iowa has developed a 7-year research-demonstration program to begin to resolve these problems: the Big Spring Basin Demonstration Project. The project focuses on the Big Spring Basin because the areas's unique setting allows study of groundwater and agriculture in ways that cannot be done elsewhere. The project is an interagency, interdisciplinary program which is developing the needed technical and institutional models. The project will cost $6.8 million; $2.4 million has been secured from state agencies, and $0.2 million from cooperating federal agencies. The additional $4.2 million is being sought from federal agencies and foundations.

INTRODUCTION

Research conducted in Iowa during the past five years has shown that chemicals associated with agriculture are now found in many of Iowa's groundwater aquifers. The chemicals of primary concern in drinking water are nitrates and pesticides. These groundwaters, which supply drinking water to both municipalities and private individuals, now commonly exhibit nitrate (NO_3) concentrations above the maximum contaminant limit (MCL) for public drinking water of 10 mg/l NO_3-N (45 mg/l as NO_3). Furthermore, trace amounts of many widely-used pesticides have also been found in these aquifers in association with elevated NO_3 concentrations.

Well construction and poor waste-disposal practices contribute to individual well problems, and spills and misuse of chemicals have caused more severe problems locally. However, the regional contamination of aquifers is the result of conventional usage of ag-chemicals and constitutes a nonpoint source pollution problem. Reports of increasing problems with NO_3 in drinking water has been the trend over the last two decades.

Much of the research, and hence much of the attention to this problem, has been focused in northeast Iowa. Such contamination, however, is clearly occurring throughout Iowa and the corn belt. As part of the studies in NE Iowa, detailed information has been compiled for the Big Spring groundwater basin in northern Clayton County (54, 57-60). The Big Spring Basin is, in part, a karst area, which creates some unique water-quality problems. However, these detailed studies have revealed that even in karst areas in Iowa nearly all the NO_3 and the majority of the pesticides reach the aquifer with infiltration recharge water. The appearance of pesticides in other aquifers, far removed from any karst features, substantiates this conclusion. Detailed research continues in the Basin, not because of its unique or severe water-quality problems, but because the area affords a unique opportunity to study groundwater in ways not possible elsewhere. In the Big Spring Basin we have

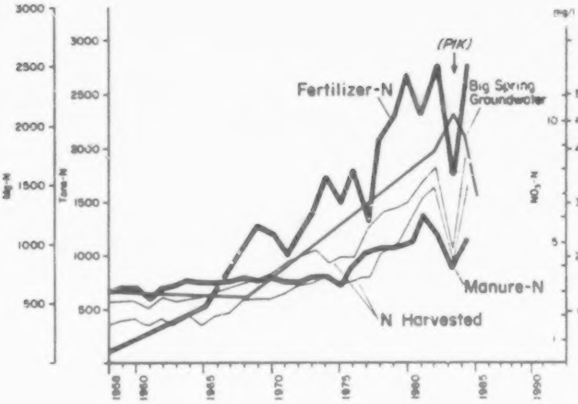


Figure 1. Tons of fertilizer-N and manure-N applied in the Big Spring basin and annual average NO_3 concentration (dashed line, right axis for scale) in groundwater at Big Spring, and tons of N harvested in corn grain (from Hallberg et al., 1984a; [58]).

a very responsive hydrologic system where we can quantitatively gage the discharge of groundwater, and hence, begin to deal with mass-balances of water and chemicals in a real world setting. The following sections of this paper will summarize pertinent observations about NO_3 and pesticides in groundwater.

NITRATE

Studies in Iowa have repeatedly shown that: 1. the natural NO_3 concentration in Iowa's groundwater aquifers is very low (often <1 mg/l NO_3-N); 2. NO_3 is leaching through the soil and infiltrating to the shallow groundwater; 3. while many potential sources of NO_3 contribute to groundwater contamination in a local area, regionally the increase in NO_3 contamination is related to the increased use of nitrogen fertilizers. Thus, where aquifers are close to the land surface, the groundwater/drinking-water supplies in the aquifer become contaminated.

During the 1950s and 60s the NO_3 concentration in groundwater in the Big Spring Basin averaged about 3 mg/l NO_3-N. By the 1980s the NO_3 had increased threefold, to an annual average of 9 mg/l NO_3-N in water-year 1982 and to 10.3 mg/l NO_3-N in 1983 (flow-weighted means from over 200 analyses) . Data from a variety of other groundwater sources showed a similar increase (58). The increase in NO_3 in groundwater directly paralleled the increase in the amount of fertilizer-N applied in the basin (figure 1). This same direct response is

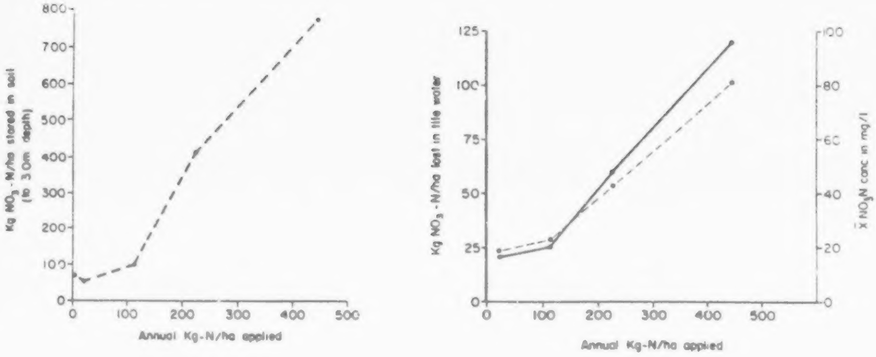


Figure 2. Minnesota experimental farm data showing the relationship between N-fertilizer applied and the amount of NO_3-N stored in the soil to 3.0 m depth, on left, and the amount lost in tile-drainage water (solid line) and flow-weighted mean NO_3-N concentration in tile water (dashed line), on right. Soil type - Webster CL; 3 years of treatment (data from Gast et al., 1978; [46]).

shown by experimental farm studies; an example is shown in figure 2 (see 54, 59 for review). This is the response that should be expected in areas with shallow aquifers, such as in the Big Spring Basin. Also, there are no industries, landfills, municipalities, or large feedlot operations in this basin to complicate the interpretation.

Figure 2 shows the relationship between rate of N-application and the amount of NO_3-N/ha remaining in the soil profile, or lost in tile-drainage water. Tile-drainage water is shallow groundwater, and the response in tiles can provide a proxy view of infiltrating groundwater, albeit at a very shallow depth. The important point of the graphs is not the absolute numbers shown, but rather the overall trend. From these and other studies (11-14, 25, 46, 54, 57, 59, 71, 72, 74, 88, 89, 92, 94, 100-102, 105, 107, 109, 115, 121), it is apparent that the amount of NO_3-N that accumulates in the soil or is lost in tile-drainage water (groundwater) increases in a direct and nearly linear fashion with N-fertilizer application rates above about 50 to 100 lbs-N/A (13, 74). This loss occurs because the amount of N made available is in excess of the amount being utilized by the crop, and the chemical-N applied is often readily converted to the mobile NO_3-N form. Many studies would suggest that the average N-fertilizer recovery for corn is in the range of about 35% (e.g., 31, 35, 70, 72, 88, 89, 92, 106). A 17-year experiment-farm study of continuous corn from NW Iowa, when corrected for no-applied N check plots, showed an average recovery of only 15% at fertilizer rates of 100 and 150 lbs-N/A (71). Recent studies using isotopically labeled fertilizers also suggest that large amounts of fertilizer-N may be leached below the root zone, sometimes before the corn is even capable of using it (e.g., 30, 100, 101). Such losses have

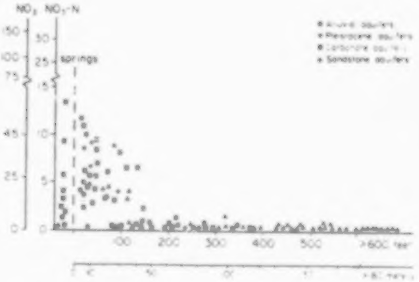


Figure 3. NO_3-N concentrations in groundwater vs. depth to groundwater tapped by well, from NE Iowa; depth represents casing depth or well-depth, where casing depth approximates total well-depth (data from Hallberg and Hoyer, 1982; Hallberg et al., 1984b; 55, 59).

been "built-in" to N-fertilizer yield-response models without fully understanding the inefficiencies and losses involved. This is also evident from studies noting the wide variance in N-fertilizer recommendations which have not resulted in significant yield differences (e.g., 89-91).

The magnitude of the nitrogen losses measured in the Big Spring Basin are also enlightening. For 3 years of monitoring the amount of NO_3-N lost from the basin in surface water and groundwater varied from 1.8 to 2.9 million pounds. These losses are equivalent to about 33 to 55% of the average amount of fertilizer-N applied during the preceding years (table 1). Furthermore, these are minimum figures for the amount of N lost because only the NO_3-N losses were computed. Other forms of N are also discharged with the water and losses by denitrification cannot be estimated. As with the studies noted above, this is not meant to imply that all of this NO_3-N is derived directly from the fertilizer-N. However, the large losses occur in response to the large amounts applied.

Across the country, NO_3 problems in groundwater are attributed to various problems--natural occurrence, mobilization of natural-soil nitrogen, septic tanks, other waste disposal, and heavy manure usage--often in combination with poor well construction. For individual wells or local areas in Iowa, septic tanks, waste disposal, and poor well construction all create problems. In some areas, heavy manure loads create the same problems as fertilizer-N, and manure must be managed properly to avoid such problems. Undoubtedly, some of the NO_3 in groundwater is derived from all these sources, but NO_3 is leaching to groundwater because of the excess amount present in comparison to crop use and removal. In many areas of intensive grain crop production the largest input of N is chemical fertilizer. When considering all the sources of N, from rainfall to soil mineralization, it is also the one variable that can be controlled. This is why the regional increases in NO_3 in groundwater directly relate to increases in N-fertilizer usage.

Infiltration is the recharge mechanism common to all groundwater and hence the leaching losses of nitrate must be expected to occur over large areas in appropriate environments. The Big Spring Basin and other work in NE Iowa has concentrated on the regionally important, shallow carbonate aquifers.

Table 1. NO_3-N losses in groundwater and surfacewater from the Big Spring Basin for three water years (Hallberg et al., 1985; [60]).

	Water Year		
	1982	1983	1984
Million lbs. NO_3-N discharged in water	1.8	2.9	1.8
Equivalent lbs-N/A total basin	27	43	27
Equivalent lbs-N/A, long-term corn-acreage*	50	75	50
Equivalent of avg. fertilizer-N applied, percent*	33%	55%	33%

* 5-yr. average, excluding PIK

In these settings the NO_3 concentration generally decreases with increasing depth below the land surface (except in some complex hydrogeologic settings in the karst-carbonate aquifers in NE Iowa). This general relationship is shown in figure 3, from data from the NE Iowa studies. Though the work in NE Iowa has concentrated on the regionally important, shallow carbonate aquifers, even these data show that the same effects are apparent in "alluvial aquifers" (sand and/or gravel in stream valleys), "Pleistocene" aquifers (sand and/or gravel buried in glacial deposits), and sandstone aquifers (large sandstone bedrock units, e.g., St. Peter and Jordan Sandstones). Even though much attention has been focused on NE Iowa through these studies, nitrate concentrations in groundwater are greater in other areas. The Big Spring Basin only averages about 60% of its area in row-crops (99% of which is corn). While the basin supports more livestock than many areas of Iowa, it is not as intensively used for row crops. For perspective, figure 4 shows the NO_3-groundwater data from Big Spring with two public supply sites from NE Iowa, which have long term records. All these sites show the same trend of increasing NO_3 in a similar time frame. However, the other sites reach greater concentrations of NO_3 with time.

Figure 5 shows the change in nitrate concentration with time in the groundwater in two alluvial aquifers in NW and WC Iowa. The same timing of major increases is apparent, but the increases in NO_3 are considerably higher than in NE Iowa. This is typically the case in western Iowa. For perspective, two other sites are shown on figure 6, both from alluvial aquifers in western Iowa. Site A is from a well in a rural town and the water-quality is known to be affected by septic tank and cesspool effluents. Site B is from another well system affected by a spill of liquid-N fertilizer in the early 1950s. At site A, high NO_3 concentrations are apparent in the 1940s, and they continue to the present with little significant change compared to the other sites described. Likewise, at site B, high NO_3 concentrations were noted shortly after the spill but had seemingly dissipated by the late 1960s. After this time the NO_3 rises again, similar in timing and magnitude to the regional changes noted in figures 4 and 5. Again, there are many local, or point sources and factors affecting the NO_3 concentration in groundwater, but statewide the concurrent increase in NO_3 in shallow groundwater from the late 1960s on is related to the greatly increased, nonpoint source use of N-fertilizers, as shown in the Big Spring Basin.

Groundwater in western and north-central Iowa is of major concern in relation to ag-chemicals because of the much greater intensity of row-cropping and attendant chemical use in these areas compared to NE Iowa (figure 7). Even as far back as 1964, the greatest herbicide use in the state was in the NC-NW Iowa regions (116). Alluvial aquifer systems are more widely used in western Iowa than in NE Iowa because bedrock aquifers are more deeply buried in western Iowa, and the alluvial systems often have had better natural water quality. Figure 8 shows locations of public water-supplies (from groundwater) where NO_3-N concentrations commonly exceed the MCL. The majority occur in western Iowa in alluvial aquifers.

Figure 9 is a summary of 13,625 groundwater samples from private wells less than 30m deep, which were analyzed for NO_3 by University Hygienic Laboratory, UHL, during 1978-1981 (data provided by Dr. R.C. Splinter, UHL). As in figure 8, it is apparent that a far greater percentage of groundwater sources exceed the NO_3-MCL in western Iowa, particularly NW Iowa, than in NE Iowa.

PESTICIDES

Unfortunately, the studies in NE Iowa show that many of the most commonly used pesticides, particularly herbicides, are also leaching into groundwater. Findings from various studies indicate several of the herbicides are persisting in groundwater year-round. In particular, atrazine is routinely found in "shallow" groundwater samples now, albeit in low concentrations. (This discussion only includes monitoring in areas of routine use. In isolated instances, from spills or siphoning accidents other pesticides and much higher concentrations have been noted.)

Table 2 shows the pesticides that have been detected in groundwater and the maximum concentrations (in micrograms/liter, or parts-per-billion), from the NE Iowa studies. Only one insecticide, fonofos, has been detected in the Big Spring Basin groundwater; however its occurrence was related to the karst run-in water component. (As noted below, however, fonofos has been detected in alluvial aquifers, where the only recharge component is infiltration through the soil.)

The occurrence of these pesticides in groundwater, as with nitrate, is not unique to the karst areas, or the carbonate aquifers of NE Iowa. Pesticides are also leaching to shallow groundwater across the state. This can be inferred from observations of pesticide concentrations in tile-effluent water (e.g., shallow groundwater) around the state. In fact, pesticide concentrations in tile effluent are very similar to those found in groundwater (8, 10, 55, 57, 59). Figure 10 shows a compilation of sites where pesticides have

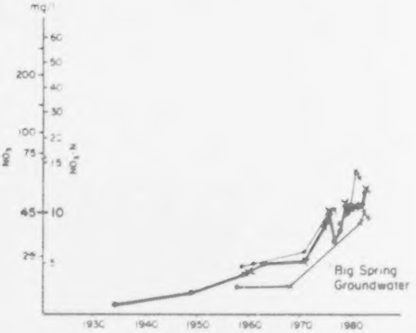


Figure 4. NO_3 concentration in groundwater with time from two public water-supply well-systems in carbonate aquifers from NE Iowa; trend in Big Spring groundwater shown for comparison. X indicates average of 3 or more samples per year.

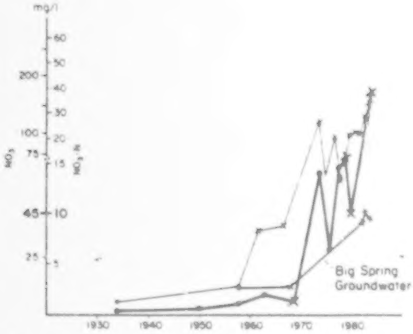


Figure 5. NO_3 concentration in groundwater with time from two public water-supply well-systems in alluvial aquifers; one from NW, one from WC Iowa; trend in Big Spring groundwater shown for comparison. X indicates average of 3 or more samples per year.

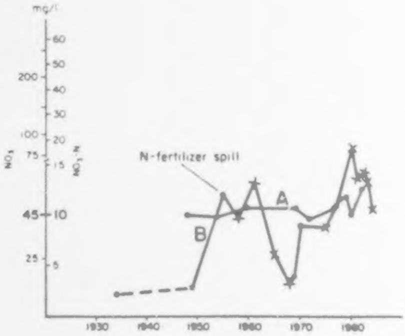


Figure 6. NO_3 concentration in groundwater with time from two PWS well-systems in alluvial aquifers from W Iowa. A - affected by septic and cesspool effluents; B - affected by N-fertilizer spill in 1951. X indicates average of 3 or more samples per year.

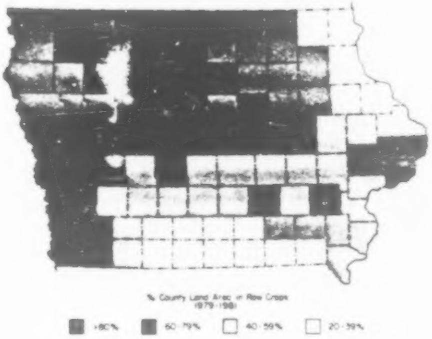

% County Land Area in Row Crops
1979-1981
>80%
60-79%
40-59%
20-39%

Figure 7. Average percent of county land-area in corn and soybeans, 1979-1981 (data from Iowa Dept. of Ag., Crop and Livestock Rept. Serv.). B - indicates location of the Big Spring Basin.

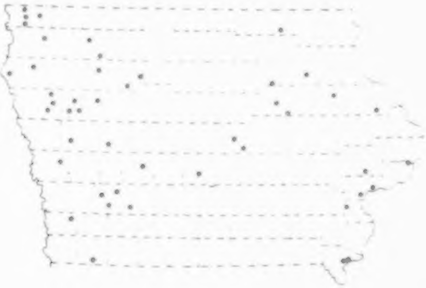


Figure 8. Public water-supplies which have exceeded the nitrate maximum contaminant level of 10 mg/l NO_3-N (45 mg/l NO_3) since 1980. Data from Iowa Dept. of Water, Air and Waste Management (R. Kelley, pers. commun.). B - indicates location of the Big Spring Basin.

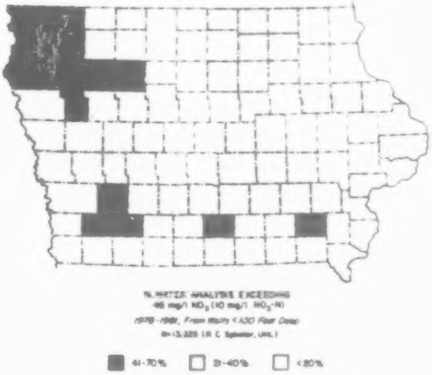

% WATER ANALYSES EXCEEDING
45 mg/l NO3 (10 mg/l NO3-N)
1978-1981, From Wells <100 Feet Deep
N=13,625 (R C Splinter, UHL)
41-70%
21-40%
<20%

Figure 9. Percent of water samples, by county, exceeding the NO_3 MCL, from private wells less than 30 m (100 feet) deep analyzed by UHL between 1978-1981. N = 13,625; 28% of all samples exceeded the MCL. (Data from Dr. Roger Splinter, UHL, pers. commun.) B - indicates location of the Big Spring Basin.

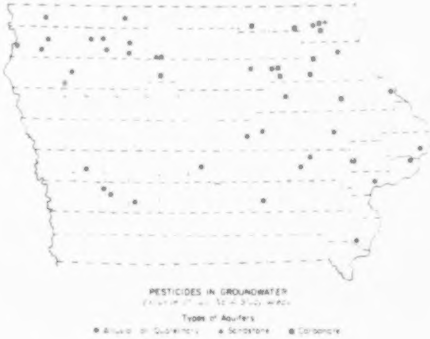

PESTICIDES IN GROUNDWATER
Types of Aquifers
Alluvial or Quaternary
Sandstone
Carbonate

Figure 10. Map showing locations where pesticides have been detected in groundwater, *exclusive* of IGS studies in NE Iowa. (Data compiled from Kelley, 1985 (76); Musterman, 1981; other IGS data; and unpublished data from; DWAWM, R. Kelley, pers. commun.; USGS, M. DeTroy, pers. commun.; and UHL, R. Spinter, L. Johnson pers. commun.).

Table 2. Maximum pesticide concentrations detected in groundwater in northeastern Iowa studies, 1981-85 (from Hallberg et al., 1983 [59], 1984a [58], 1985 [60]; Libra et al., 1984, [78]).

Common Name Active Ingredient	Maximum Concentrations µg/l (ppb)				
	Big Spring Basin				Floyd/Mitchell Co. and other areas
Herbicides	WY-82	WY-83	WY-84	WY-85	WY-82/83
atrazine	2.5	5.1	10.0	6.1	10.0
alachlor	0.2	0.6	4.0	5.0	16.6
cyanazine	0.7	1.2	1.7	4.6	0.5
metolachlor	---	0.6	4.5	4.6	0.3
metribuzin	---	---	---	3.6	4.4
2, 4-D	NA	NA	NA	0.2	---
Insecticides					
fonofos	---	0.1	0.3	0.35	
	Flow-weighted Mean Atrazine				
	0.18	0.28	0.45	0.70	

been detected in groundwater in Iowa, exclusive of the detailed NE Iowa studies. Most of these sites are from alluvial aquifers, or buried (Pleistocene) aquifers which occur throughout the state. These sites are primarily public water-supply wells.

Table 3 shows the maximum pesticide concentrations found in the alluvial well sampling. The list is similar to that from NE Iowa with the addition of chloramben and dicamba. To date, the analyses have only been for parent compounds, and it is not known if metabolites, or breakdown products, of these or other pesticides are present. Studies are now beginning that will address this question.

Temporal Changes in Pesticides in Groundwater. Prior to the initiation of the studies in NE Iowa there were few data available about pesticides in groundwater supplies. The only time well-water samples were analyzed for pesticides was when spills or siphoning accidents occurred. It was generally thought that pesticides would not leach to groundwater, except under rare circumstances.

Table 2 summarizes some of the pesticide data from groundwater from the Big Spring Basin study. Note that over the four years of research the maximum concentrations of each individual pesticide has generally increased. These maxima occur with run-in recharge events, but for water-year 1984 and 1985 most of these maxima came during early spring events, prior to the new

Table 3. Maximum pesticide concentrations detected in groundwater from alluvial/Pleistocene aquifers in Iowa. Data from DWAWM, IGS, USGS, UHL sampling.

Common Name Active Ingredient	Maximum Concentrations µg/l
Herbicides	
atrazine	3.0
alachlor	0.7
cyanazine	1.4
metolachlor	4.5
metribuzin	0.8
chloramben	1.7
dicamba	2.3
Insecticides	
fonofos	0.9

application of pesticides. It does not appear that this trend is simply an aberration of the timing of recharge events. More importantly, note in Table 2 that the flow-weighted mean atrazine concentration has increased every year, in spite of major differences in climatic patterns. (The flow-weighted mean averages the concentrations in relation to groundwater discharge and compensates for many variations related to differences in water-flow, sampling intensity, etc.) Though few pesticide-groundwater data are available before these studies, some other "proxy" data are available. Between 1968 and 1982 the UHL monitored pesticide concentrations in surface waters, near public-water supply intakes, at 12 sites around Iowa. The sampling was initiated because of concerns with chlorinated-hydrocarbon pesticides such as DDT and dieldrin. The sampling was conducted monthly, and while some samples were taken during runoff events, few were taken during large flood flows. Over the course of the year many of the samples must have been derived from stream base-flow, which in Iowa is comprised of groundwater which sustains stream flow. Thus, these data comprise at least a proxy view of groundwater conditions.

Analysis of the data is not yet finished but figure 11 provides an overview of the results. Data on the now-banned pesticides dieldrin and DDT and its by-product DDE go back to 1968. Over time, residues of DDT and DDE were detected less frequently, and by 1981 samples seldom contained detectable residues. This same trend has been noted nationally (48). Dieldrin on the other hand has continued to show up in about 35-40% of the samples. However, Dieldrin has a very strong affinity to attach to particles (clay, organic matter, colloids) and its appearance was often related to even minor turbidity, and the concentrations were very low (<10 parts per trillion).

In 1975 UHL modified procedures and began analyzing for the more "modern" pesticides which came into use. Although some changes in methods took place after 1975, detection limits remained nearly the same, and the trends shown are not an artifact of new methods. For all the modern herbicides the trend is the

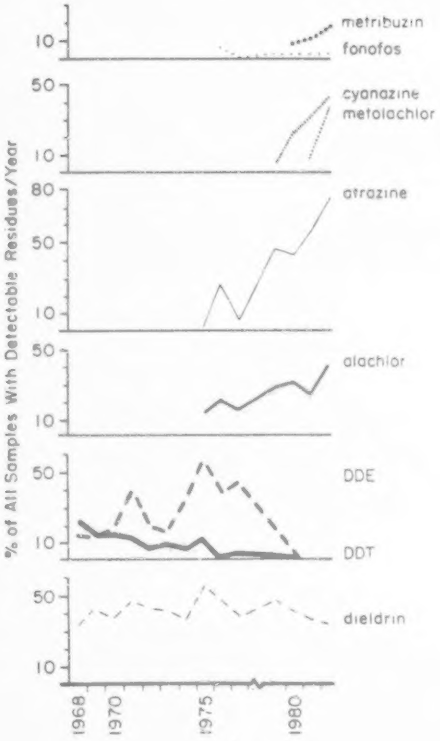


Figure 11. Percent of all samples per year, from monthly sampling of 12 surfacewater sites, which had detectable pesticide residues, vs. time (Data from Dr. R. Splinter and Dr. L. Johnson, UHL, pers. commun.).

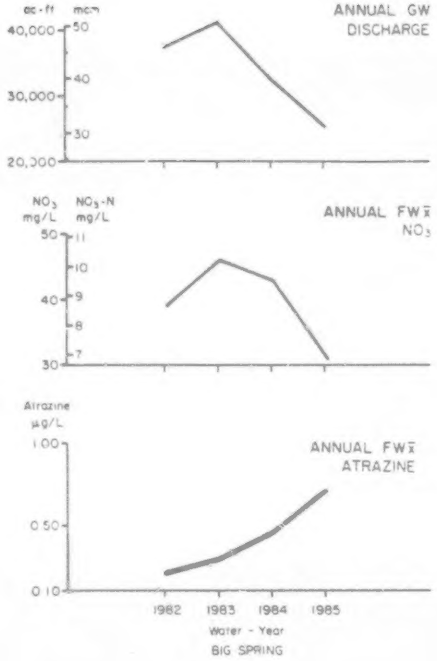


Figure 12. Summary of 4 years monitoring data from Big Spring showing groundwater discharge, flow-weighted mean NO_3-N and atrazine concentrations.

same (figure 11). All increase in their persistence with time; e.g., atrazine to nearly 80% by 1982, alachlor and cyanazine to 40 to 50%. By 1980, at some sampling stations a number of the herbicides were present even in winter base-flow samples. This clearly suggests that low concentrations of these chemicals were persisting in the groundwater which provides the base-flow discharge of the streams.

These data overlap in time with the beginning of actual groundwater sampling in the Big Spring Basin. In the Big Spring area initial samples collected in the fall and winter of 1981-82 had no detectable pesticide residues. Pesticides first appeared in groundwater samples in early spring 1982 and have been there ever since. This continues the same pattern apparent in figure 11.

As noted on Table 2, for Big Spring groundwater, the flow-weighted mean atrazine concentration has increased steadily from year to year. Figure 12 shows a summary of 4-years' data from Big Spring. After many years of high-nitrogen applications, the NO_3 moving into groundwater is in relative equilibrium with the water flux: the more water that moved through the soil and into groundwater (as noted here by groundwater discharge) the higher the NO_3 content of the water. Thus, with the prolonged dry conditions of 1985, water-flux was much reduced; so were NO_3 concentrations. However, note that the flow-weighted mean atrazine continued to increase, regardless of the decrease in water-flux. This divergence in trend is a compelling indication that the increase in concentration of pesticides in groundwater is real, and not an artifact of climatic conditions.

Clearly, the data presented in figures 11 and 12 imply that pesticide residues in groundwater are on the increase, certainly in terms of persistence, if not concentration as well. These observations suggest we are at the beginning of a trend of ever-increasing occurrence of residues in groundwater in response to prolonged and widespread use, perhaps analogous to the rise in NO_3 of a decade ago!

SURFACE-WATER PROBLEMS

In Iowa about 6% of municipal water-supplies and 2% of all public-water supplies rely solely on surface water. Over the past years a great deal of money and energy has gone into resolving some of our surface-water quality problems. Great strides have been made in Iowa, and the nation as a whole, in developing sewage treatment facilities and working with industry to control point source discharges into streams and lakes. Yet even where waste treatment efforts have essentially eliminated point source NO_3 inputs, high NO_3 loads have continued or increased in many streams.

This is where the interconnection between groundwater and surface water again plays a role. The high NO_3 concentrations that appear in our streams are related to periods of high recharge from shallow groundwater into the streams. The NO_3 is mobilized by water infiltrating through soil, recharging shallow groundwater, which then discharges into surface waters. This is the 'hydrologic' cycle at work. Thus, the timing of NO_3 fluctuations is related to seasonal recharge, not to the timing of seasonal agricultural practices. This is why NO_3 concentrations in streams (and wells) increase during spring recharge, often several weeks before N-fertilizers are applied.

As noted previously, groundwater baseflow also contributes low concentrations of pesticides into surface waters. With pesticides, however, the larger runoff discharges in streams (which are low in NO_3) are of concern. Depending on the timing of runoff events, high concentrations of pesticides can result (see Wauchope, 1978, [117]), even in the larger streams used for water supplies. For example, concentrations of 70 µg/l atrazine and over 100 µg/l alachlor have occurred in major Iowa streams. These peak concentrations are short-lived, but not uncommon.

LOCAL PROBLEM AREAS

The potential health effects from these low concentrations of pesticides occurring in groundwater/drinking water are unclear. However, situations are arising that are much more serious, and have caused the closing of both public and private water-supply wells. These situations all occurred in the immediate vicinity of local farm-chemical supply dealerships. Table 4 summarizes data from 8 such case studies where groundwater contamination has been found. It must be noted that these situations turned up inadvertently (from routine monitoring of public water-supplies, for example). These were not cases where anyone was clearly suspected of negligence or improper handling of any chemicals.

Table 4 summarizes pesticide concentrations found in pools of water or the soils in loading, handling, and equipment rinsing areas. Many of the concentrations are in the range of formulation concentrations. In these problem areas note that the chemical concentrations in the local groundwater/drinking water are increased 10-fold for NO_3, and *100 times* for pesticides, over the background concentrations in the area. Also because of the localized high concentrations other pesticides and chemicals, which have not been detected elsewhere, are leaching to groundwater; e.g.--trifluralin and fumigants such as EDB and carbon tetrachloride.

EXAMPLES AND COMPARISONS FROM OTHER AREAS

These groundwater-quality problems related to agriculture, as discussed above, are not unique to Iowa. A few examples from other areas are presented here, for perspective.

Nitrates. As previously noted, increases in NO_3 concentrations in groundwater, directly related to agriculture, have been documented across the 'corn belt' (15, 24, 42, 46, 49, 50, 62, 77, 88, 89, 92, 94, 97, 101, 102, 107, 114, 115), across the U.S. and Canada (8, 11, 12, 13, 55, 57, 59, 62, 74, 85, 99, 110), and throughout the world (1, 4, 5, 36, 51, 62, 64, 110, 111, 121). Numerous studies show a direct relationship between NO_3 concentrations in groundwater and N-fertilization history (2, 4, 5, 13, 36, 46, 51, 58, 59, 62, 65, 85, 88, 94, 97, 101, 105, 110). Far afield from the midwest trends similar to figure 1 have been documented. In Europe, NO_3 in groundwater increased from about 1 mg/l, NO_3-N, to 15 mg/l over a 10 year period, related to high rates of N-fertilization (36). Figure 13 shows the concurrent trends in increased fertilizer use and the increase in NO_3 from a carbonate-groundwater spring in an agricultural area in France. The setting, and the results, are very analogous to the data for the Big Spring Basin (figure 1). In summary, Baker and Laflen (1983), in a review of agriculture and water-quality, state that:

Table 1. Pesticide and nitrate concentrations from 8 case studies where groundwater has been contaminated in the vicinity of farm-chemical supply dealerships.

	Maximum Concentrations Detected		
	In Pools and Soils in Loading and Rinse Areas	Groundwater in Affected Wells and Seeps	Local Background Groundwater
Herbicides	--- --- --- --- ---	µg/l --- ---	--- --- ---
atrazine	70,000	65.0	ND - 0.65
alachlor	270,000	145.0	ND - 1.30
cyanazine	225,000	36.0	ND - 0.26
metolachlor	270,000	50.0	ND - 0.80
metribuzin	52,000	8.0	ND
trifluralin	(1,000+)	0.2	ND
Insecticides			
carbofuran	(1,000+)	ND	ND
fonofos	(1,000+)	1.3	ND - 0.3
Fumigants			
EDB	(10	1.0	ND
1,2,dce	to	2.0	ND
Carbon Tet	100)	66.0	ND
Chloroform		4.0	<1.0
	--- --- --- mg/l	--- --- ---	
Nitrate (NO_3-N)		137-480 (30-105)	18-41 (4-9)

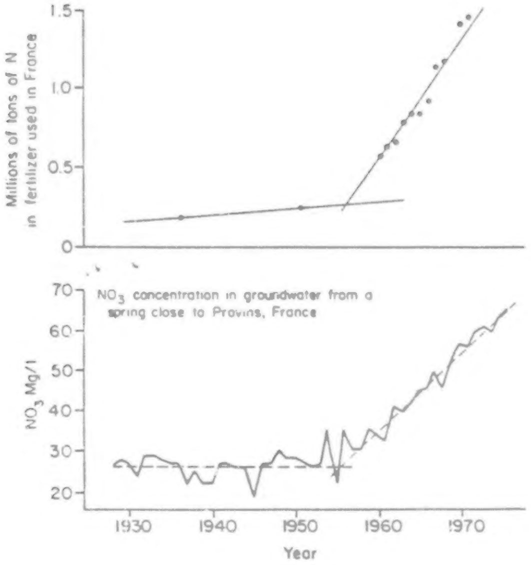


Figure 13. Tons of N - fertilizer used in France, and nitrate (NO_3) concentration in a carbonate groundwater spring in an agricultural area (after Pierre, 1983). (To convert NO_3 to NO_3-N multiply by 0.22.)

"NO_3-N losses with subsurface drainage related in nearly linear fashion to N-application for rates exceeding 50 kilograms per hectare."

These trends are not unique. The increase in fertilizer usage in the Big Spring Basin simply parallels the trends for Iowa and the nation as a whole. Across the cornbelt the average N-fertilization rate increased from about 65 lbs-N/A in 1965 to 135 lbs-N/A in 1982 (61). A decade ago there was justifiable skepticism about the role of N-fertilizers and whether or not NO_3 concentrations were actually increasing in water. There was a great deal of rhetoric about all the other sources of N in the environment (see 33, 84, 89). The considerable research since then, world-wide, has clearly shown that NO_3 leaching does occur in response to extensive N-fertilization.

In the Hall County, Nebraska project, N-fertilizer application rates were reduced nearly 80 lbs-N/A with no reduction in yields over 4-years, simply with good N-management (Frank et al., 1984 [42]; Olson, 1985 [91]). For Nebraska as a whole, Olson (1985 [91]) estimates that, since 1968, N-fertilization rates have exceeded annual crop requirements by 20% to 60% per year. Using similar conservative estimates, harvested corn grain can only account for about 30% to 50% of the N-fertilizer applied to corn in Iowa over the past five years. In the Big Spring Basin inventories of ag-practices and conservative estimates show that fertilizer-N, alfalfa-N, and manure-N account for at least 50% more N than needed for crop production (75, 93).

Pesticides. There are not many studies that have dealt in detail with pesticides in groundwater. The problems associated with aldicarb in groundwater in Long Island, N.Y., Wisconsin, and Florida have been widely noted (e.g., 32, 104, 124), as have problems with EDB and DBCP in Georgia, Florida, and Hawaii (e.g., 32, 82). A variety of excellent research has been ongoing in Nebraska, dealing with atrazine in groundwater (e.g., 52, 118, 119). Atrazine is noted to persist year-round in these studies.

In a now out-of-date review, Cohen and others (1984 [32]) note the occurrence of 12 pesticides in groundwater from 18 different states (these data were compiled prior to most of the work noted here). Various pesticides have been detected in groundwater in at least 8 of the 14 states (U.S.) in the North-Central Region. Some unpublished reports that have not found any residues have also not had adequate sampling or analytical protocols to detect them.

Recently, more studies have been initiated to look at pesticides in groundwater. In an RCWP project in South Dakota 2,4-D has been noted (77); in Pennsylvania, in an RCWP watershed study, the four commonly-used herbicides in the area have all been detected in groundwater (Table 5). The herbicide types and concentrations are similar to those noted in Iowa. The authors also note that concentrations are rather uniform year-round.

Some watershed and plot studies have begun to measure and note the occurrence of pesticides in shallow groundwater, as measured in "subsurface" flow, tile-flows, winter stream base-flow, etc. In Maryland, low concentrations of alachlor and atrazine have been noted (122) in corn-cropped areas. In forest, silviculture areas persistent hexazinone residues have been noted in shallow groundwater from Georgia (86) and Arkansas (18) and picloram was found in Georgia (87). In some studies of tile-drainage water much higher concentrations of herbicides (e.g., atrazine from 70-175 μg/l) have been noted, particularly in the eastern part of the corn belt (49, 107).

In northern Ohio a number of major municipalities depend on surface water for their drinking water-supplies. Even after treatment moderately high concentrations of a variety of herbicides persist in these finished waters (6, 7). Some of these data are summarized in Table 6.

These surface water monitoring data from Ohio (6, 7) show the same high NO_3 flux from groundwater into the surface water described above (figure 13). Of particular note, however, these groundwater base-flow data show much higher pesticide concentrations than found in Iowa. Other groundwater "proxy" data, such as tile-effluent monitoring in northern Ohio (107) also show flow-weighted average atrazine concentrations of 70-150 μg/l--10 to 100 times greater than Iowa data.

Problem areas, around local farm-chemical supply dealers have also been noted in other states, including South Dakota (50) and Wisconsin.

THE DILEMMA

With our current state of knowledge about ag-chemicals and groundwater/drinking water, we are presented with a classic dilemma. We have few definitive answers for any aspect of these problems. Sometimes, those of us involved in agriculture assume a defensive posture about these issues. On the one hand, one hears phrases such as: It's only our new technology that even allows us to detect these *minute* concentrations of pesticides," but on the other hand, the nature of these chemicals *demand* detection. Some note that "the dose determines the poison," or some pesticides are less toxic than

Table [illegible] Maximum herbicide concentrations measured in 43 private wells. Pennsylvania, RCWP, 1983 (Thompson, 1984 [114]).

	µg/l
alachlor	3.0
atrazine	3.0
metolachlor	0.4
simazine	3.4

aspirin. True, but most are far more toxic. However, the health concerns, with the low concentrations that are occurring (and that are likely to occur) are generally not with acute toxicity, but rather with the unknown, chronic effects of long-term exposure. (Even aspirin is not considered wholly safe in this regard.)

Again, with the modern advancements of this chemical age people are living longer, and most would concede, better than ever before. This is in large part because of medical advancements and the food-nutritional improvements provided by modern agriculture. On the other hand, one of those modern advancements that the rural community is generally well aware of, was the development of groundwater as a safe drinking water source. Many of the epidemics of generations past (e.g., typhoid and cholera) were spread by contaminated surface water. It is also for the very reason that people *are* living longer that exposure to chemicals is of concern. People now outlive the diseases of the past and hence are concerned with exposure to chemicals which may be associated with, or contribute to, birth defects, cancer or other chronic health problems.

This is not a problem to be ignored. As recently noted by Bartholic (1985 [15]): "Groundwater quality protection is becoming the focus of the next wave of public, governmental, and private activism in the environmental arena." The public is becoming increasingly anxious over these issues. In a recent food marketing survey 73% of the people polled considered pesticide contaminants the most serious hazard in their food chain (USA Today, 7/17/1985, p. 1D). Let me end this review with a brief summary of the concerns and needed directions.

Public Health Concerns. The occurrence of potentially toxic or hazardous chemicals in groundwater/drinking water, even in low concentrations, is of real concern because of the potential for long-term and widespread exposure to the public. At the present time, only relatively shallow aquifers are affected. However, this may simply be a function of time. Over time, if such chemicals persist in groundwater, they will be transmitted to deeper aquifers.

Concerns for nitrate have generally centered around drinking water for infants and the problems of methemoglobinemia. While this problem is relatively well-understood, cases still occur. Methemoglobinemia is not a reportable illness in most states, hence, there are few accurate statistics

Table 6. Maximum herbicide concentrations measured in finished water of 3 public-water supplies using surface waters in northern Ohio, 1980-1982 (Baker, 1985 [6]).

	µg/l
alachlor	14.3
atrazine	30.0
cyanazine	2.4
linuron	0.6
metolachlor	24.2
simazine	1.0

available. In spite of recent "pronouncements" at some meetings, acute cases do still occur, and at least four cases can be documented in western Iowa, eastern Nebraska, and southeast South Dakota in recent years (e.g., 23). The pesticide concentrations, which are being routinely detected, are far below toxic levels and generally well below levels thought to contribute to long-term, chronic problems such as cancer. An exception to these statements is in some local areas, as shown by the case studies around formulation sites. However, there are many uncertainties involved with the combinations of pesticides and their metabolites that occur in relation to other environmental factors. For example, pesticides in groundwater nearly always appear in conjunction with high nitrates. With triazine herbicides the possibility exists for combination with N-compounds to form nitrosamines, most of which are carcinogenic or mutagenic. The implications of the coexistence of these chemicals in drinking water with microbial pathogens (in untreated rural supplies) and with other man-made organic compounds or metals (59, 60, 67, 76) are unknown. The potential widespread, but unforeseen, exposure to the public of pesticides through drinking water (in combination with other routes, i.e., food, occupation, etc.), and the possible synergistic interactions with other contaminants, may necessitate a wholesale reevaluation of risk assessment protocol.

The ag-chemical industry expends a significant effort on acute toxicity studies in developing new chemicals, and affirming the viability of older ones. Most of these lab studies focus on acute toxicity and sub-acute assessments such as cancer incidence, tumor incidence, mutagenicity, and fetal abnormalities. More subtle, chronic problems are not generally assessed and are very difficult to assess (e.g., 123). Testing is restricted to individual chemicals and it is problematic to extend these results to the public environment where these mixtures of chemicals in water and foodstuffs may interact. Bioassays of actual environmental mixtures may produce significantly different toxicity results than extrapolation from criteria on individual chemicals (96). Health officials in New York dealing with aldicarb contamination in groundwater note (Zaki et al., 1982 [124]): "The lack of evidence to support or negate a causal relationship at present does not mean that we, as public health officials, can ignore the presence of these toxic contaminants in groundwater until further documented studies prove the presence or absence of such evidence. On the contrary, any responsible health agency should assume that these contaminants represent a potential hazard to public health and act accordingly."

It is difficult to prove the long-term health impacts of such environmental problems. Various epidemiological studies suggest cause for concern and point to the clear need for more intensive study. For example, recent studies in Europe and Australia suggest that elevated nitrate concentrations in drinking water may be associated with other health problems ranging from hypertension in children, to gastric cancer in adults, and fetal malformations (38, 43).

Mortality from some cancers is significantly higher in rural-farm families. From aggregate studies on the county level, excessive mortality from leukemia, multiple myeloma, and non-Hodgkin's lymphoma is consistently associated with area herbicide usage (16, 22, 25, 26). Ingestion of ag-chemicals through drinking water is considered a possible mechanism causing farm families to be at higher risk (22). Other studies (67) have shown likely associations between man-made chemical contaminants in drinking water and the incidence of other cancers, as well. Cancer is frequently studied epidemiologically because of the availability of cancer registry data. Such data are not readily available for many other health problems.

While such studies do not prove cause and effect, patterns of risk do emerge. These patterns point the direction for further needed studies. Unfortunately epidemiologic 'proof' often takes a generation of exposure.

Economic Concerns. The foremost concern in the agricultural sector today is the depressed state of the agricultural economy. This again is an intricate dilemma: decisions on national economic and agricultural policies, well beyond the influence of the farmer, have dramatic influences on the farm economy. Policies urging full production have been out-of-synch with policies for soil and water conservation. Ag-chemicals have become a form of insurance as the farmer has struggled with short-term cash-flow problems. As the farmer now is considering the need for greater net efficiency and net profit we must evaluate if we have been "over-insured."

The chemical losses noted from groundwater and experimental farm studies highlight one area of economic inefficiencies in current agricultural management. The studies in the Big Spring Basin (Table 1) and other on-going research clearly suggest that, beyond the environmental concerns, the magnitude of the N-losses observed are of economic concern as well. When 50 to 70 percent of the chemical-nitrogen applied is not going into grain production there is obvious room for improved efficiency and economic gain. As noted, these concerns reach much further than NE Iowa. Even in areas where the leaching of ag-chemicals has not affected drinking-water supplies it is still affecting shallow groundwater and the same chemical inefficiencies are apparent. In Iowa alone, farmers now spend over $400 million annually for N-fertilizer.

In contrast to the N losses, the pesticide losses are generally quite small. The total losses of pesticides to both groundwater and surface waters are generally less than 5% (8, 9, 13, 59, 117). Under some soil and tillage conditions some studies suggest higher losses of 10-15%, however (107). In contrast to nitrogen these figures do not provide as obvious an economic incentive to improve management. Given the environmental concerns with pesticides it is clear that even these losses should be minimized.

There can be substantial costs involved for either individuals or municipalities if they have to drill new wells. or develop additional water treatment because of these water-quality problems. There are, of course, real economic impacts associated with adverse, long-term health effects, but the effects are unknown.

Technical Concerns. The extensive occurrence of ag-chemicals leaching to groundwater raises various technical concerns. Primarily it illustrates that in spite of all our prior research, there are obviously important factors involved in water and chemical behavior which we have not understood.

Perhaps the primary factor is the importance of the preferential flow of water through macropores, even under unsaturated conditions. Flow through macropores and other discontinuities in the soils plays a major role in the leaching of both NO_3 and particularly pesticides (e.g., 19, 30, 37, 40, 68, 81, 108, 115, 121). Pesticides are noted in particular, because it was thought that most of the currently used pesticides would remain in the topsoil environment, in part because of their relatively rapid degradation and the tendency for many pesticides to attach to sediments or organic matter.

In many studies of nitrogen in the soil, especially those related to N-response yield studies, leaching has often been overlooked. The literature is replete with studies (see reviews in 57, 59, 78) where 10-50% of the N-fertilizer could not be accounted for and this lost N was either attributed to denitrification and gaseous losses, or as simple error, lost in the morasse of N-sources and transformations. Leaching frequently has simply not been considered. Still substantial N research goes on that only considers what transpires in the upper few cm or tens of cm of the soil. This is not to negate the need for such research, but the conclusions about N-losses must be derived with care. Recent research with labeled-N allows positive identification of the applied chemical-N and, as noted previously, leaves little doubt that rapid downward movement of N-fertilizer occurs in many settings (30, 100, 101, 121). As a consequence, significant N-losses and inefficiency have been built in to fertilizer requirements.

Traditionally, our concern with agricultural nonpoint source problems has focused on soil erosion and the delivery of sediment, organic matter, nutrients, and chemicals into surface waters. While these are serious problems which must be dealt with, often our standard approaches to resolve these problems have been short-sighted and have not considered the potential impacts on groundwater. For example, terraces will control runoff and erosion, but by preventing runoff they clearly increase infiltration and the leaching of NO_3 to groundwater (2, 59).

In this regard, concerns have been raised about the effects of conservation tillage (6, 7, 13, 63), because of associated increases in chemical usage and possible increases in leaching losses. (Other concerns for increased chemical concentrations in runoff are addressed in references 8, 13, 59). Results from the few studies conducted to date are equivocal (see 8, 59), in part because few studies have looked at the whole of the soil-water system. Some studies have shown greater leaching losses of NO_3 and pesticides under zero-till systems compared to conventional-tillage (moldboard plow) (49, 107, 115), in part related to flow through macropores. In contrast, other studies have shown less leaching of NO_3 under zero-till (8, 17, 83, and on-going studies at ISU). The differences between tillage systems noted in these studies are generally in the realms of 3-8%, and what we must focus on is the first 20-50% leaching losses (i.e., for NO_3) that may occur under any system.

Obviously, some new initiatives are needed in research and demonstration. The interaction of tillage practices, chemical placement practices, and water flux through the soil is complex. As our understanding of water and chemical movement has become refined, we must put these insights to work. We must incorporate our understanding of preferential flow and chemical transformations into management systems to take advantage of these processes to minimize our losses.

DIRECTIONS

The ongoing research described in this report is providing a definition of the problem between land application of ag-chemicals and groundwater quality. Now we must work toward solutions. Our present system of voluntary efforts to deal with agricultural NPS problems are being seriously questioned. The debate has begun on the development of new legislative, regulatory, and enforcement programs to deal with agricultural NPS and ag-chemicals (e.g., 34). Amidst this debate it must be realized that as long as chemicals are land applied, within the vagueries of climatic conditions, that losses into the environment cannot be eliminated--but they clearly can be minimized.

These groundwater quality problems can only be resolved through a more holistic approach to agricultural management. We must couple our standard concerns for soil conservation and surface water quality with the need to protect groundwater, as well. New combinations of many current practices may be needed, and better chemical and nutrient management must play a part. A cooperation of government agencies, university researchers, and extension personnel is needed to design needed research and demonstration projects and implementation strategies. Agribusiness and industry also must play a role. A coordinated effort is needed to define cost-effective management alternatives, new technology, and education programs that can be applied to these problems.

In Iowa, a cooperative interagency program has been developed under the banner of the Big Spring Basin Demonstration Project. The project is designed to document and demonstrate economically viable ag-management techniques to protect groundwater from the nonpoint source contamination of agricultural chemicals. The seven-year program is being conducted in the Big Spring Basin in northwest Clayton County not because of the severe water-quality problems, but because the area's unique geology and hydrology allow us to study groundwater in ways that cannot be done elsewhere.

Ag-chemical management research, combined with special educational programs, form the core of the Demonstration Project. Experimental farm plots will be developed to document management practices and to demonstrate their potential to area farm managers. The research-demonstration work will integrate standard microplot, plot, and field size demonstrations where both total water-quality and crop production effects can be documented. Drawing upon research results, education programs will assist farm managers to employ efficient fertilizer and pesticide management techniques within their farming systems. These programs will be combined with special assistance in the areas of soil conservation, and nutrient and pesticide management. The project also includes economic analyses of management practices, a thorough evaluation of surface-and groundwater quality, and an evaluation of how effective educational programs can be in implementing a nonpoint source, groundwater-protection strategy.

The entire project is projected to cost 6.8 million dollars. Currently, 2.6 million dollars has been secured for the project. Most of this comes from existing services pledged by agency programs, but it includes several grants, contracts, or commitments from special project programs. The additional 4.2 million dollars is absolutely necessary to assure the success of the project. These funds are being sought from federal sources, as well as from foundations which might consider participation in such a project. The total funding still being sought constitutes less than 1% of the money Iowa farmers spend on ag-chemicals in a single year, which points out the potential cost-effectiveness of such a project. The project includes the active cooperation and participation of the following agencies: Agricultural Experiment Station (ISU), Clayton County Soil Conservancy District, Cooperative Extension Service (ISU), Department of Agronomy (ISU), Institute of Agricultural Medicine (U of I), Iowa Conservation Commission, Iowa Department of Soil Conservation, Iowa Department of Water, Air and Waste Management, Iowa Geological Survey, Northeast Iowa Conservancy District, University Hygienic Laboratory (U of I), U. S. Agricultural Stabilization and Conservation Service, U. S. Environmental Protection Agency, U. S. Geological Survey, U.S. Soil Conservation Service, and the Iowa Fertilizer and Ag-Chemical Dealer's Association.

As noted by Timothy Amsden, Director, Office of Ground Water Protection, USEPA-Region 7 (1985):

> "The rural community is the most ground water dependent segment of society - the family on the farm drinks ground water directly without treatment, and uses it for irrigation, livestock watering, and other purposes... The rural community, more than any other segment of society, is beginning to express a need for greater regulation of the use of pesticides and nitrates, in order to protect the ground water upon which they so completely depend... The farmer or rancher... has much greater control over the activities on the land overlyaing his ground water; in fact, he probably conducts most or all of those activities himself. The fate of his ground water, therefore, lies in his hand and those of his neighbors."

Resolving these problems will require a concerted effort by all segments of the agricultural community to gain the experience and data necessary to affect a satisfactory balance between efficient agricultural production and the protection of our water supplies.

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AGRICULTURAL RESEARCH SERVICE

PLAN FOR GROUNDWATER QUALITY RESEARCH

Executive Summary

Introduction

Major efforts are needed to ensure long term good groundwater quality. The Agricultural Research Service (ARS) has made significant contributions in the areas of salinity, pesticides and nutrient management research, and has developed several models that simulate these processes. The agency, with its expertise in pesticide chemistry, microbial research, soil chemistry, soil physics, agricultural and civil engineering, and hydrology, will play a major role in future groundwater quality research. ARS is well qualified to conduct multidisciplinary research, to identify groundwater quality issues and develop economical viable management systems to alleviate present and avoid or prevent future problems.

The Groundwater Quality Problem in Relation to Agriculture

Agriculture has a tremendous stake in the resolution of issues and problems associated with dissolved solids and chemicals in groundwater. Agriculture is a major groundwater user for irrigation, livestock and drinking water and therefore it has an invested interest in protecting this supply.

In the 48 conterminous United States, about 86 percent of the total water resource is in groundwater aquifers. Groundwater is the source of about 24 percent of the nation's fresh water supply and its use is increasing at an annual rate of about 4 percent. About 50 percent of the U.S. population depends on groundwater sources for drinking water. In rural areas, about 95 percent of the household depends on groundwater. Of the total groundwater withdrawal, 68 percent is used for irrigation of cropland. This represents about 35 percent of the total water used for irrigation. Therefore, groundwater pollution, real or potential, is of significant concern to the nation.

Contamination of an aquifer may persist for years or decades after removal of the contamination source due to the slow rate of groundwater movement, and the lack of both chemical and biological activity in the vadose (the zone between the bottom of the root zone and the groundwater table) and groundwater zones. In many areas of the country, groundwater and surface water are interconnected. Therefore, surface and groundwater quality may not be separate issues.

In a recent compilation of water resources and water quality issues developed by the Geological Survey, 10 states identified concerns over pesticides in groundwater and 12 states identified nitrate enrichment as a present or emerging problem. Of particular concern was movement of chemicals in karst areas of northeast Iowa, southeast Minnesota, and southwest Georgia. A recent compilation of incidences of pesticides found in groundwater list 11 pesticides with incidences of one or more detected in 13 states. Most experts agree that water quality problems associated with agricultural chemicals are likely to be limited to a few compounds or a combination of compounds and physiographic conditions. Currently, no national data base exists to evaluate the extent of this problem.

Salinity, or dissolved solids, is also identified as a groundwater quality problem in arid areas of the U.S. Many of the soluble salts are of natural origin, but current irrigation water practices may increase salinity where excess irrigation water carries natural salts that have been concentrated by evapotranspiration below the root zone or excess water dissolves crystalline salts from the underlying geological formations.

Some point sources of concentrated chemicals on farms and on the property of commercial applicators near chemical storage, handling and mixing sites are of concern. Similarly, the disposal of unused pesticide mixtures from aerial and ground application equipment is a problem.

Questions related to levels of agricultural chemicals in groundwater and their relationship to agricultural practices are difficult to assess when considering the long travel times to and within an aquifer system and the fact that many aquifers are recharged in areas remote from the site of withdrawal. Models to help answer these questions and to predict potential chemical loading to groundwater from different agricultural management systems, physiographic regions and climatic scenarios must be based on sound concepts and well established fundamental processes and validated with field data. Models must be able to answer questions relative to the efficacy of production systems and the crop production goals. Knowledge of processes occuring in the vadose zone is severely limited as most agricultural scientists have limited their studies to the root zone and groundwater scientists have been interested primarily in deep aquifer systems. Much remains to be learned about the transport of salts and chemicals in the vadose zone and in shallow groundwater and discharge zones.

Current ARS Research and Recent Progress

The current water quality research commitment in ARS exceeds $6 million, but about 90 percent has been devoted to developing technologies for assessing and enhancing the quality of surface waters. Funding of groundwater research has not been adequate since the formation of ARS in 1953.

The current ARS program on groundwater quality is described under four major categories: (1) nutrients; (2) pesticides; (3) salinity; and (4) modeling.

Recent progress in groundwater quality is based on advances in agricultural chemical technology and soil and water chemistry in eight areas:
(1) efficiencies of use; (2) integrated pest management; (3) improved chemical disposal practices; (4) environmental modeling; (5) soil chemistry;
(6) salinity; (7) nutrients; and (8) process models.

High Priority Groundwater Problems That Must Be Solved

There are many agriculturally related groundwater quality problems but three broad problems are of utmost importance: (1) occurrence of pesticides in groundwater; (2) occurrence of nutrients in groundwater; and (3) salinity as influenced by irrigation practices.

The following list of 12 specific high priority groundwater quality problems relate to these broad problems. Major emphasis in identifying these problems is placed on understanding the processes that occur in the vadose zone because it has been neglected.

The high priority problems identified in the Work Group report are grouped by program orientation (chemical and biological processes, model development and testing, and management and control). Specific research approaches most likely to solve the problems within each area are identified. These approaches are not all new or inclusive, but represent ongoing research that needs to be strengthened. Following are the 12 problems in priority order; and presented in abbreviated form.

1. Determine the behavior of chemicals as they move in the subsurface environment.
2. Develop fundamentally based models of all physical and chemical processes of groundwater movement.
3. Develop better methods of characterizing the subsurface environment.
4. Determine fundamental relations between biological and chemical processes, and pesticide characteristics.
5. Determine the magnitude of agricultural chemical contaminations.
6. Determine the effect of changing agricultural technology on groundwater quality.
7. Determine the effect of water management and tillage on chemical movement.
8. Develop models for planners to use in assessing alternative production systems.
9. Develop models to guide managers in the application of agricultural chemicals.
10. Determine the effect of water movement and tillage on soil microbials.
11. Develop fundamental principles to guide development of new pesticide formulations.
12. Develop a data base and data base management system.

Recommended Plan for Allocation of Increased Resources

A plan to expand or initiate groundwater quality research will require an estimated 25 SY's at a cost of $5 million annually net to locations. The recommended level of support $200,000 per SY is high because of the expense involved in this type of research. The proposed distribution of these resources by priority research areas is provided in the report.

Expected Benefits of Groundwater Quality Research

Groundwater, once contaminated, may remain so for many years. Protecting groundwater quality is a very complex and difficult issue. A significant and appropriate role for ARS is understanding how agricultural activities and the use of agricultural chemicals affect groundwater quality. Because large quantities of agricultural chemicals are used over much of the U.S., agricultural systems are considered potential sources of groundwater contamination. The benefits to be derived from increased research on groundwater quality are based on the fact that the cost of prevention will almost certainly be less than the cost of correction. Improved water management, conservation tillage and other cropping systems will evolve, new chemical control technologies will be developed and fertilizers and pesticides will be used more efficiently.

Policy and Cooperative Mechanisms

It is the policy of ARS to conduct research and develop technology that will provide groundwater of acceptable quality for irrigation and other agricultural uses and to assure that the agricultural impact on groundwater quality is minimal.

Maintenance of and an active involvement of several interdepartmental, interagency and regional coordinating committees will be necessary to insure an effective research program. Work groups involving USDA and EPA will coordinate the planning of research on the quality of groundwater impacted by agriculture. A work group involving ARS and SCS will coordinate research as needed to meet SCS needs in groundwater quality. A work group involving ARS and the USGS will coordinate the modeling of the vadose and the groundwater zones and a multidisciplinary ARS work group will be involved in coordinating the groundwater quality research program.

INTRODUCTION

Concern for the quality of the nation's groundwater resources is expressed by many agriculturalists and most governmental agencies. However, it has been only in the last few years that major efforts have been made to ensure good groundwater quality. The Agricultural Research Service (ARS) has made significant contributions in the areas of salinity, pesticide, and nutrient research and in simulation model development. Because of the multidisciplinary scientific expertise that the Agency has in pesticide chemistry, microbial research, soil chemistry, soil physics, agricultural and civil engineering, and hydrology, ARS will play a major role in future groundwater quality research. ARS is well qualified to conduct multidisciplinary research to identify the technical and scientific groundwater quality issues, and develop economically viable management systems to alleviate present and prevent future problems.

The Agricultural Research Service is responsible for conducting research and developing technology that will ensure high quality groundwater for use in agricultural production and where agricultural land impacts the water. To this end, on February 28, 1984, Dr. T. J. Army, Deputy Administrator of ARS appointed a multidisciplinary workgroup of fourteen scientists to develop an ARS Plan for Groundwater Quality Research. The Workgroup completed their planning efforts on April 18, 1984 in Beltsville, Maryland. This document is the result of that effort.

The panel was composed of:

W. C. Shaw, Chairman
D. A. Farrell, Vice Chairman
H. Bouwer
D. G. DeCoursey
J. Feldmesser
R. F. Follett
D. S. Frear
M. R. Gebhardt
D. E. Glotfelty
M. E. Jensen
P. C. Kearney
R. A. Leonard
H. B. Pionke
R. D. Wauchope

Many other scientists were contacted for their contributions and recommendations.

GROUNDWATER QUALITY - THE PROBLEM IN RELATION TO AGRICULTURE

SUMMARY

There is increasing evidence that the nation's groundwater resources are becoming affected by man's activities, including those associated with agriculture. Advances in analytical chemistry often allow detection of chemical concentrations at levels so low that information is lacking on toxicological significance. However, monitoring results indicate that agricultural chemicals are present in groundwater. Even if concerted efforts are made, the extent of the problem may not be adequately assessed for several years. Since about one-half the total United States population and 95 percent of rural households depend on groundwater for drinking supply, research programs are needed immediately to: (1) define the extent of the problem, (2) develop procedures for estimating potential loading of chemicals to groundwater systems, and (3) develop alternative management systems to alleviate or minimize the occurrence of agricultural chemicals in groundwater. Movement through the vadose and groundwater zones can be very slow, anaerobic conditions exist, and biological and chemical processes that degrade contaminants may be much less effective in groundwater than in surface soils. Therefore, strategies that prevent chemical entry into groundwater will be much more effective and less costly than groundwater clean-up strategies.

Agriculture has a tremendous stake in preventing groundwater contamination. Chemicals are indispensable in modern agriculture; but their improper use may lead to serious water quality problems that could impair its use for crop and animal production and domestic water supply.

The USDA-ARS is uniquely qualified to organize multidisciplinary teams of agronomists, engineers, chemists, geologists, and other soil, plant, and watershed scientists to address the problem. These teams would be qualified to evaluate flow and transport of chemicals through the vadose zone, which links the surface environment with the groundwater environment. Other agencies and organizations may concentrate on problem definitions and regulations. ARS can seek problem solution through development and testing of alternative management systems.

THE GROUNDWATER QUALITY PROBLEM IN RELATION TO AGRICULTURE

The United States enjoys an abundance of fresh surface water and groundwater. Present supply and availability from a national perspective was recently summarized (U.S. Geological Survey, 1984). In the conterminous United States, the renewable supply is about 1400 billion gallons per day, three times the present withdrawal rate and 14 times the national consumptive use. The actual availability of this water is, however, determined by its distribution in space and time and by the way this resource is developed and managed. The availability of water is always limited in the Colorado River Basin, the Rio Grande Basin, the Great Basin, parts of the High Plains and parts of California, and seasonally over much of the remaining United States.

In recent years as the rate of reservoir construction and development of surface water supplies diminished, more economical well drilling, improved or more efficient pumps, and low cost energy led to accelerated groundwater usage. In the lower Colorado River Basin, the High Plains, and California, groundwater withdrawals are occurring at rates that well exceed recharge rates. This "mining" has withdrawn enough water that the water table has dropped to the point that further removal is costly. In humid areas such as Florida and the Atlantic Coastal Plain, recharge rates of shallow aquifers are high and usually exceed withdrawal of rates. In this case, groundwater utilization results in diversion of water from streamflow or evapotranspiration rather than extended withdrawal from storage. Recharge of deep aquifers in the Coastal Plain is much slower and withdrawal rates likely exceed recharge.

In the 48 conterminous states, about 86 percent of the total water resource is in groundwater aquifers (Council for Agricultural Science and Technology, 1982). Groundwater is the source of about 24 percent of the nation's fresh water supply with utilization increasing at an annual rate of about 4 percent. Of the total groundwater withdrawal, 68 percent is for irrigation of cropland. This represents about 35 percent of the total used for irrigation (U.S. Water Resources Council, 1978 and USGS, 1984).

About 50 percent of the U.S. population depends on groundwater sources for drinking water. In rural areas about 95 percent of the households depend on groundwater (U.S. Environmental Protection Agency, 1984a). Therefore, groundwater pollution, real or potential, is of significant concern. Once an aquifer becomes contaminated, the effects may persist for years after removal of the contaminating source, due primarily to the slow rate of groundwater movement, but also to the lack of both chemically and biologically active zones as contrasted to soils. In many areas, groundwater and surface water are interconnected. About 30 percent of the nation's streamflow is supplied by groundwater seepage (U.S. Water Resource Council, 1978). Much of this occurs in the humid East and North. In contrast, the hydraulic gradient in the semiarid and arid West is such that streamflow recharges groundwater. Therefore, surface and groundwater quality may not be separate issues, but a combined issue where the quality of one can have great impact on the other.

Within this report, groundwater is defined as that portion of the underground water that is above atmospheric pressure. Aquifers are geologic formations containing groundwater that are sufficiently permeable to produce flow to wells. Unconfined aquifers are bounded by a free water surface (water table) at the top. Confined aquifers are sandwiched between impermeable or slowly permeable layers. Perched groundwater is formed by water temporarily retained (moving) above restricting layers.

Groundwater quality has become an issue of intense public concern. Increased efforts to identify, and astronomical costs to clean up hazardous waste disposal sites, and extensive news media coverage have heightened public concern over all potential point and nonpoint pollution sources. Advances in analytical chemistry, with increasing sensitivity for detection of low level contamination, and the growing list of substances labeled carcinogenic and mutagenic, have had a significant impact on the public's perception of the problem.

The Environmental Protection Agency (EPA), in its report to Congress on nonpoint source pollution in the U.S. (U.S. EPA, 1984b), cites several examples of nonpoint source groundwater pollution by pesticides and nitrates. The U.S. Geological Survey (1984) compiled a comprehensive document on water resources and water quality issues. Ten states specifically identified concerns over pesticides in groundwater, twelve states identified nitrate enrichment as a present or emerging problem. Of particular concern was movement of chemicals in karst areas, such as northeast Iowa, southeast Minnesota, and southwest Georgia. Cohen et al., 1983 and Severn et al., 1983 provide compilation of reported incidences of pesticides in groundwater. The list includes 11 pesticides with reported incidences of one or more detected in 13 different states. However, no national data base exists to evaluate the extent of the problem. It will take 5 to 10 years of concerted effort to develop data bases for adequate statistical evaluation of the groundwater pollution problem (Josephson, 1981).

In developing a regulatory groundwater protection strategy, the Environmental Protection Agency classified sources of groundwater pollution according to their perceived severity (U.S. EPA, 1984a). Industrial landfills/lagoons, municipal landfills/lagoons, underground storage tanks, and chemical oil and brine spills were labeled major problems. Intermediate problems were: well injection, pesticides, fertilizers, and septic tanks. Minor problems were salt water intrusion, road salts, and feedlots. Problems associated with wastewater treatment, land application of wastes, and mining activity were labeled as variable; depending on site specific conditions.

When all agricultural chemicals and quantities used are considered, water quality problems created are likely limited to a relatively few compounds or combinations of conditions. The potential for pesticide leaching appears related to exceeding limits on solubility, volatility, hydrolysis, and photolysis of the pesticide as well as groundwater recharge rate (Cohen et al., 1983 and Severn et al., 1983). However, the problems identified arouse public concern for the entire spectrum of chemical use. This document refers to "agricultural chemicals" only in the generic sense, meaning all chemicals, pesticides, fertilizers, and regulators used in production of food and fiber on the farm.

Salts and salinity are often identified as groundwater quality problems in the arid U.S. These salts are of natural origin; however, current surface water management practices may contribute to increased salinity. This occurs where excess irrigation water carries salts concentrated by evapotranspiration below the root zone, or dissolves salt accumulated in geologic formations.

Possible exposure of groundwater to concentrated chemical source areas, especially pesticides on farms and the property of commercial applicators, occurs near chemical storage, handling, and mixing sites. The disposal of unused pesticide mixtures from aerial and ground application equipment is a serious problem. Inaccurate application caused by poor controls can result in excessive concentrations of pesticides and other chemicals in the field, especially at field edge and in turn-rows.

Agriculture has a tremendous stake in proper resolution of issues and problems associated with salts and chemicals in groundwater. It is impossible to meet the rapidly growing world needs for agricultural products without use of chemicals. With use of chemicals comes the responsibility for developing farm management systems that have minimum impact on groundwater quality. Since agriculture is a major groundwater user for irrigation, livestock, and drinking water, it has a vested interest in protecting this supply. Information, technology, and analytical and predictive methods are not sufficiently available nor developed to provided needed strategies and management technologies required for both groundwater resource protection and utilization. Solving the problem requires the development of methods to identify chemical and salt sources, routes and control measures, and to determine the efficacy of these measures in controlling chemical and salt loss to groundwater as caused by agricultural activities.

Although there has been considerable research on fate of chemicals in soils, streams, and impounded waters, serious gaps exist in data bases, basic concepts, and the understanding of processes that define groundwater quality. Proper implementation of regulatory decisions and development of alternate management systems requires that these gaps be filled. For example, the EPA may place strict controls, through labeling or bans, on the use of "potentially threatening pesticides" over Special Aquifers, and the EPA will establish advisory levels for pesticides in groundwater. The concept of the Special Aquifer, as yet a proposal, is an irreplaceable source of drinking water or those that are ecologically vital because they provide base flow for a particularly sensitive stream ecosystem (U.S. EPA, 1984a).

Regulations or restrictions on fertilizer use and animal production over these Special Aquifers could follow, particularly in response to problems arising from nutrient enrichment of base streamflow in sensitive ecosystems.

Obviously, other questions will arise in implementation of regulatory programs or development of alternative management practices. How are "advisory levels" in groundwater related to current agricultural practices when travel times to and within aquifer systems may be unknown? What does "over" an aquifer system mean? Often aquifers are recharged in areas remote from where the supply well taps the groundwater system. How are those combinations of soils, geology, chemical properties, and chemical use patterns identified that constitute a potential threat? What levels of risk will be accepted considering expected rainfall patterns?

Models based on sound concepts and validated with field data will be needed to predict potential chemical loading to groundwater systems under different management and climatic scenarios. What are the impacts of conservation tillage systems on groundwater quality especially with respect to herbicide and nitrate leaching potential? Because these are not known, officials in Wisconsin do not encourage no-till practices (U.S. EPA, 1984b). Any future changes in production practices involving shifts in amounts and types of agricultural chemicals will raise similar questions. Finally models must answer questions relative to efficacy and crop production requirements. A proposed management system cannot be considered as a viable alternative unless basic production goals are met.

In addition to improving and updating hydrologic, chemical, and biological models for the root zone, similar type models must be developed for routing chemicals to and through the groundwater system. Knowledge of processes occurring in the vadose zone (that zone between the groundwater and the land surface, the root zone being the top of the vadose zone) is severely limited. Traditionally, agricultural scientists have limited their studies to the root zone or solum; groundwater scientists have been primarily interested in deep aquifer systems. As a result, much needs to be learned about transport in the vadose zone between the bottom of the root zone and the groundwater system. In addition to the vadose zone, very little is known about transport and behavior of chemicals in shallow groundwater and discharge zones. In the Northern Plains and the humid U.S., the vadose, shallow groundwater and discharge zones have great impact on the quality of downstream flows. The roles of fluctuating water tables, flow paths, travel times, chemical transformations and microbial activity in these zones must be determined.

IMPACTS OF AGRICULTURAL RESEARCH ON GROUNDWATER QUALITY

Only a small fraction of the enormous variety of chemicals used in agriculture is responsible for documented groundwater quality problems. The problems identified are serious and demand our attention, but they could have been much worse. That they are not is due to recent progress that has been made in our knowledge of agricultural chemicals, how they behave in the environment, and how to use them in agricultural systems.

The registration process now administered by EPA prevents most pesticide impacts before they happen. Persistence, mobility, and other environmental effects--are all limited, or at least defined, by current registration procedures. The pesticide registration process has, in general, accomplished its goal of keeping chemicals with potentially serious environmental impact out of the marketplace. However, continued research is necessary because all probable impacts cannot be foreseen. Impacts of nitrate and other plant nutrients on groundwater, while not controlled by registration procedures, are limited by economic criteria dictating their efficient use.

Our knowledge of agricultural chemicals and soil and water chemistry is the result of basic research in eight areas: (A) efficiencies of use; (B) integrated pest management; (C) improved chemical disposal practices; (D) environmental modeling; (E) soil chemistry; (F) salinity; (G) nutrients; and (H) process models.

A. Efficient use of agricultural chemicals minimizes potential for adverse impact.

Important advances in the efficiency of agricultural chemical use include:

1. Improvements in applicator equipment:

   - automatic sprayer control systems
   - precision groundspeed and airspeed measurement
   - chemigation principles and practices
   - herbicide wiper/roller application equipment
   - fertilizer and pesticide incorporation equipment
   - precision pesticide placement in soils and on plants

2. Precise determination of chemical application timing and rates:

   - more precise soil testing and fertilizer recommendations
   - more efficient fertilizer scheduling and placement
   - pest population scouting, modeling, and economic threshold determinations
   - precise irrigation scheduling and application minimizes chemical leaching
   - more precise pesticide application based on soil and climate factors

3. Improvements in the chemicals:

    - nitrification inhibitors
    - controlled-release formulations
    - drift control additives
    - adjuvants and/or surfactants for increased pesticide activity, selectivity, and specificity
    - increased selectivity, activity, and specificity of active ingredients
    - development of postemergence weed control and other chemicals that are effective at extremely low rates

These technical advances have improved pesticide and fertilizer application efficiency, lowered the rates of chemical application, and reduced the amount delivered to the non-target environment. Thus, advances in chemical use efficiency have decreased crop production costs and reduced environmental contamination.

B. Development of integrated pest management practices allows more judicious use of chemicals.

A diverse arsenal of pest control practices has been developed that supplements improvements in chemical application technology and allows the chemicals to be used more efficiently:

1. Pheromones, allelochemicals, and semiochemicals exploit weaknesses in the behavior of pests.

2. Breeding has produced more competitive and/or pest-resistant crop plants.

3. Production and cultivation practices, such as crop, chemical, and tillage rotations that maximize chemical use efficiency are used frequently.

4. Biological control techniques have been developed that use natural enemies of pests.

Producers have responded by to incorporating these cost-effective practices into integrated pest management systems.

C. Improved pesticide storage, handling, and disposal practices decrease point-source pollution.

Producer and applicator awareness of the need for proper storage, handling, and disposal has increased through education. Improvements in packaging and incineration methods and awareness of disposal problems have reduced point source contamination.

D. Basic knowledge of agricultural chemical behavior and fate in soils and water provides a predictive capability that can be built upon.

The developments listed in A, B, and C mean that agricultural chemicals are being used more efficiently and safely. However, they will remain a major crop-production tool. Thus, techniques for predicting chemical movement and fate, in a given crop/soil/moisture environment, are necessary.

Recent progress in examining and modeling several related parts of the system include:

1. Improvements in understanding of surface-water hydrology and chemistry.

2. Models of root-zone leaching and persistence of chemicals.

3. Better knowledge of groundwater hydrology.

4. Identification of soil properties that control chemical movement.

5. Description of the metabolic and chemical pathways of most chemicals in the root zone.

Output from these models can be used to estimate inputs to the vadose zone. The models also provide a first screening for those chemical/site combinations that are or are not likely to be a problem. Extending the models to include the vadose zone will require research data, but (i) enormous strides have been made in our ability to model the processes; and (ii) model complexity is no longer a limiting factor because computer power has grown immensely.

E. Basic knowledge of the kinetics of salt precipitation and dissolution in soils.

Important advances include:

1. Kinetics of salt precipitation and dissolution in soils.
2. Ion exchange with the soil's cation exchange complex.
3. Carbonate kinetics, particularly as influenced by the carbon dioxide concentration in the soil.
4. Dispersion and diffusion of salts in soils as influenced by water uptake by plants and the leaching fraction.
5. Basic theory on the flow and transport of dissolved solids.

F. Development of methods for indirectly assessing soil salinity using electromagnetic devices and classifying saline waters and soils.

Information developed by the ARS U.S. Salinity Laboratory has been used as an international standard for decades. Important advances include:

1. Salinity sensors for monitoring soil salinity.
2. Laboratory instruments for assessing physical and chemical characteristics of soils.
3. A four-probe device for soil salinity measurement.
4. An electromagnetic probe for indirectly measuring soil salinity.

G. Basic knowledge of the quantity of nitrate nitrogen moving below feedlots to the groundwater and the chemical reactions that occur within the formation.

Collection of basic data and development of the processes controlling nitrate nitrogen movement below feedlots has been instrumental in the development of practices to reduce the amount of nitrogen and its movement below feedlots.

H. Development of models of both chemical processes and water movement.

Recent advances in analytical description of pesticide kinetics, the movement of water in saturated and unsaturated zones, and chemical adsorption/desorption phenomena have led to development of improved models of these processes. These developments have enabled us to use models in research and development.

CURRENT ARS RESEARCH RELATED TO GROUNDWATER QUALITY

The Agricultural Research Service has been engaged in research on the linkage between agriculture and environmental quality for more than a quarter of a century. As is evident from the previous section, contributions to environmental improvement have come both from research on natural resource management and from advances in crop production and protection technologies. Current ARS research continues to focus on improved soil and water management and on more effective and efficient use of agricultural chemicals. A substantial component of the ARS program contributes indirectly to the development of technologies for improving groundwater quality. Ongoing research will provide a sound scientific basis for evaluating the effect of changes in cropping, cultural, tillage, and water management on groundwater quality. It will also provide better guidelines for improving the formulation and application of agricultural chemicals.

Although the water quality research commitment in ARS currently exceeds $6 million, almost 90 percent has been devoted to developing technologies for assessing and enhancing the quality of surface waters. Funding of groundwater quality research has not been adequate since the formation of ARS in 1953.

The current ARS program on groundwater quality will be discussed under the following headings: nutrients, pesticides, salinity, and modeling.

A. Nutrients

Nutrient research at a number of ARS locations relates indirectly to groundwater quality. For example, at some locations scientists are discovering ways to more efficiently use plant nutrients. This research increases the producer's profit, and improves groundwater quality by minimizing excess nutrient content in the root zone. Results of current irrigation and drainage research will better define the effect of water management techniques on nutrient movement in the soil. At some locations, scientists are conducting research on nitrogen transformations in the root zone, near-stream zone, wetlands and impoundments. Such nitrogen transformations are crucial to the movement and impact of nutrients in groundwater systems.

ARS research directly related to groundwater quality is limited. Some information is being obtained on nitrate flux to groundwater systems. Research is also underway to determine the impact of nutrient transport and reactions in groundwater systems on the nutrient content of streams and down-gradient aquifers. ARS is only beginning to explore the geochemistry of deep groundwater as affected by land use. Finally, models to describe nutrient movement in saturated/unsaturated flow systems, and to better define mass balances, are being developed.

B. Pesticides

ARS has a basic research program on the detection, movement, sorption, binding, plant uptake, microbial metabolism, and volatility of pesticides in soils and its related systems. Segments of this research are being conducted in 7 laboratories at 6 locations (MD, MS, LA, AR, GA, CA). No one location has the facilities to conduct the research required to satisfy all the demands of this complex area. Unique pesticide problems exist at certain specific geographic locations. At several locations, ARS is conducting limited research directly related to pesticide movement in the vadose zone and underlying aquifers. This research provides soil-water partition coefficients useful for predicting pesticide leaching into the root zone and eventually into groundwater.

Herbicide persistence, leaching, and possible groundwater contamination are being investigated under conservation tillage conditions. Measurements are being made of EDB, DBCP, aldicarb, atrazine, butylate, phenamiphos, alachlor, chlorothalonil, chloropicrin, ethoprop, and pendimethalin in groundwater from wells. The possible transmission of pesticides via groundwater into the Chesapeake Bay is being investigated. Public water supplies and reservoirs in central Maryland are being monitored for the presence of herbicides.

C. Salinity

Control of salts in the root zones of irrigated lands is necessary if the productivity of these lands is to be maintained. Leaching is the only practical method of removing excess salt. The leachate or deep percolation water necessary to remove these salts moves and returns to the river as subsurface return flow, or it moves down to the underlying groundwater. The ARS program on groundwater salinity is directed toward improved understanding and modeling of water and chemical transport. The objective is to more accurately assess and control the contributions of irrigated agriculture to the total salt loading of aquifers. The principal processes under investigation include the kinetics of salt precipitation and dissolution in soils, ion exchange, carbonate kinetics, and the dispersion and diffusion of salts in the soil profile. Techniques are being developed to use isotope ratios to trace the origin of leachates from natural or man-made sources. In addition, the potential for reducing salt movement to groundwater by reducing the "leaching fraction" of applied irrigation water is being evaluated.

D. Modeling

ARS is involved in analytically simulating (modeling) most of the physical and chemical processes affecting chemical movement in the environment. Many of these models are related to groundwater quality, even though not specifically developed for that purpose. Major models such as EPIC (Erosion Productivity Impact Calculator), SWRRB (Simulation for Water Resources in Rural Basins), SPUR (Simulation of Production and Utilization of

Rangelands), NTRM (Nitrogen, Tillage, Residue Management Model), CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems), and SWAM (Small Watershed Model) all have components that relate to groundwater quality. All of them simulate the movement of water in the root zone; many of them simulate nutrient cycling and chemical movement in the root zone; and the SWAM Model includes a complete groundwater quality submodel.

Most ARS scientists include models of the systems they are studying as part of their research programs. The models related to groundwater quality include pesticide models that simulate adsorption-desorption, volatilization, microbial decomposition, and related processes. Transport in both the vadose and groundwater zones has been simulated. Most nutrient cycle subsystems have been modeled. The transport of conservative and non-conservative soluble materials through the vadose and groundwater zones has been simulated. The movement and concentration of salts in both natural and irrigated lands have been modeled. The transport processes of these subsystems are dependent upon good representation of the movement of water since it is the transporting medium. The movement of water is well described in most mediums and subsystems; infiltration, unsaturated and saturated flow, in two and three dimesional format and in stochastic as well as deterministic settings. Many of the models have been developed principally as descriptions of the physical processes, but others are being developed with the planner or manager in mind.

HIGH PRIORITY GROUNDWATER PROBLEMS THAT REMAIN TO BE SOLVED

The complexity of the groundwater quality problem indicates difficulty in obtaining a viable solution. The complexity also means that there are a large number of research topics that must be resolved. Among agriculturally related groundwater quality problems, three are most important: occurrence of pesticides in groundwater, occurrence of nutrients in groundwater, and irrigation driven salt water migration. The following descriptions of highest-priority research problems apply to all three areas. Major emphasis in problem statements is placed on the vadose zone because it is poorly understood. Other poorly understood zones include the shallow groundwater and groundwater discharge zones in humid areas. Although, both the root zone and permanent groundwater zones may be better understood, research is needed to improve estimates of groundwater recharge and discharge.

The high priority problems presented are listed in priority order from 1 through 12. More descriptive material on each of the problems is presented in the Appendix in the form of specific research problems that should aid the researcher in attacking the general problem statement.

High Priority Groundwater Quality Problems -- Priority Order

1. The form, fate, and patterns of behavior of organic and inorganic substances as they move through the root, vadose, and groundwater zones are not well enough known to predict their occurrence.

2. Analytical descriptions (models of the physical processes governing the movement of water and chemicals through soil, vadose, and groundwater zones) are not complete enough to characterize water quality.

3. Existing technologies do not provide adequate methods of sampling, measuring, or characterizing the spatial and temporal variability, flux rates, and other features of the physical environment in the soil, vadose, and groundwater zones.

4. The biological, chemical, and physical factors that govern nutrient transformation and mediate pesticide efficacy, stability, fate, and behavior in root, vadose and groundwater zones are not known well enough.

5. The source, extent, and occurrence of agricultural chemicals (pesticides, heavy metals, and nutrients) is not known well enough to predict their concentration and impact.

6. The degree to which application technology, irrigation, and changing agricultural production systems affect the chemical and water flux in the soil, vadose, and groundwater zones is not well known.

7. The effectiveness of water management and tillage practices in controlling the movement of water and its soluble biodegradable constituents through an interacting soil medium has not been well established.

8. Planning and action agencies need analytical tools (models) to predict the impact of alternative agricultural chemical applications, water management, and production systems on groundwater quality.

9. Managers and action agencies need analytical tools (models) to help assess risk and obtain optimal applications of fertilizer and pesticides with minimal water quality effects for given soils, geomorphology, and cultural practices.

10. Information on the effects of various water management and agricultural production systems on changes in soil microbiota which affect the efficacy, persistence and breakdown of agricultural chemicals is inadequate.

11. New pesticide formulations are needed to improve efficacy, reduce application variability and minimize the possibility of soil and groundwater contamination.

12. Data bases and data base management systems are needed to effectively utilize existing and new data for model testing and validation.

HIGH PRIORITY PROBLEMS AND RECOMMENDED RESEARCH APPROACHES

BY PROGRAM ORIENTATION

The highest priority problems identified in the previous section of this report are grouped by program orientation and further described by example and brief illustrative statements in the following presentation. Specific research approaches most likely to solve the problems are identified. The approaches are not all inclusive or new. They represent ongoing research that needs strengthening or new research required to solve the groundwater quality problems.

A. Chemical and Biological Interactions and Processes

1. The form, fate, and patterns of behavior of organic and inorganic substances as they move through the root, vadose, and groundwater zones are not well enough known to predict their occurrence (Priority 1).

   Even though there are numerous unsolved problems of water and chemical movement in the root zone, less is known about the vadose and groundwater zones. Very little information is available to characterize the chemical transport, reactions, adsorption, and decomposition rates in the vadose and groundwater zones. The degree and type of microbial activity in the subsurface environment is poorly understood and its impact on decomposition of chemicals is not known. Recommended research approaches are:

   a. Quantify the relationships between chemical transport rates, physical properties, and water flux in the vadose zone.

   b. Evaluate the microbial dynamics within the vadose and groundwater zones.

   c. Assess the reactivity of chemicals under conditions that exist within the vadose and groundwater zones and determine if the speed of these reactions is important.

   d. Determine the effect of soil incorporation, and surface and foliar application on the degradation and movement of pesticides in the vadose zone.

   e. Determine the effect of pesticide formulations on their fate in the vadose and groundwater zones.

   f. Identify and quantify the dominant processes controlling salt and chemical concentration and transport in the shallow groundwater and shallow groundwater discharge zones.

2. The biological, chemical, and physical factors that govern nutrient transformation and mediate pesticide efficacy, stability, fate, and behavior in root, vadose and groundwater zones are not known well enough (Priority 4).

   This problem requires fundamental research into the dynamics of biological and chemical processes and their interaction with the physical state of the environment in the vadose and groundwater zones. Geochemical processes, pesticide metabolism, microbial activity, and other dynamic processes influence the efficacy, stability, and fate of pesticides. Solution to these problems will require the close cooperation of engineers and chemists investigating both the state of the subsurface zones and chemical and biological processes. Recommended research approaches are:

   a. Determine the effects of enhanced metabolism, and edaphic and environmental conditions on the fate of pesticides in the vadose zone.

   b. Evaluate the processes that affect the fate of pesticide in various agroecosystems.

   c. Evaluate the microbial activity that causes transformations of nutrients and pesticides in the vadose and groundwater zones.

   d. Determine the effect of tillage and other production practices on pesticide use.

   e. Develop predictive relationships between soil properties and pesticide adsorption/desorption kinetics.

3. The source, extent, and occurrence of agricultural chemicals (pesticides, heavy metals, and nutrients) is not well known enough to predict their concentration and impact (Priority 5).

   Most fundamental research will require an assessment of the nature and concentration of agricultural chemicals in the vadose and groundwater zones. In some cases, this could involve extensive groundwater investigations; for example, the identification of plumes associated with point sources of contamination or the characterization of spatial and temporal variability of chemical concentrations. Recommended research approaches are:

   a. Identify and determine the concentration of salts and chemicals in the vadose and groundwater zones.

   b. Develop computerized analytical methods for identifying salts and chemicals in the vadose and groundwater zones.

   c. Develop better methods for assessing seasonal and spatial variability of salts and agricultural chemicals in groundwater.

B. Model Development and Testing

1. Analytical descriptions (models of the physical processes governing the movement of water and chemicals through soil, vadose, and groundwater zones) are not complete enough to characterize water quality (Priority 2).

   Accurate models of all the physical processes governing chemical dynamics and the fluxes of water and chemicals through the subsurface zones are needed as an aid in groundwater quality research. Modeling activity and fundamental research on the physical processes must proceed together to obtain synergistic benefits. Physical process models are also needed before good predictive and management models can be developed. The process models developed must include chemical and physical processes, and the dynamics of microbial activity and the integration of these processes with each other. Recommended research approaches are:

   a. Develop concepts that improve the accuracy, precision and ability to satisfactorily characterize heterogeneous systems.

   b. Improve the configuration of existing groundwater models to incorporate temperature, pH, and concentration gradients as driving forces.

   c. Improve models of chemical subsystems and cycles, water fluxes, sorption and desorption kinetics, redox and microbial dynamics by use of more physically based descriptions.

   d. Develop models that accurately integrate physical and biological processes.

   e. Develop more accurate descriptions of pest dynamics and thresholds.

2. Existing technologies do not provide adequate methods of sampling, measuring, and characterizing the spatial and temporal variability, flux rates, and other features of the physical environment in the soil, vadose and groundwater zones (Priority 3).

   Improvement in understanding and the ability to characterize groundwater quality depends upon fundamental research and development of physical process models. Both of these in turn are dependent upon a much better characterization of the subsurface than we now have; i.e. spatial and temporal variability of conductivity, cracked formations, preferential flow paths, etc. New instruments and more efficient methods of mapping subsurface features are needed. Recommended research approaches are:

   a. Develop instrumentation and procedures to improve state-of-the-art measuring techniques for characterizing the physical environment within the soil, vadose and groundwater zones.

b. Develop methods and procedures for characterizing voids, holes, and other variables associated with physical features of the soil, vadose, and groundwater zones.

c. Develop guidelines for selection of problem land areas within a given watershed and develop methods to extrapolate from point information to larger land areas.

3. Planning and action agencies need analytical tools (models) to predict the impact of alternative agricultural chemical applications, water management, and production systems on groundwater quality (Priority 8).

The development of predictive models to evaluate the impact of alternative water management and production systems on groundwater quality will evolve from basic process models and fundamental research. Such models will be needed to predict the nitrogen budget of soils under different management systems and to assess rural groundwater quality, subject to both point and nonpoint sources of contamination. Scientists will use such models in a simulation mode to help them develop management systems models for action agency use. Recommended research approaches are:

a. Determine the effect of agricultural production systems and soil and water management practices on the fate of chemicals in the soil, vadose and groundwater zones.

b. Determine the effect of reduced levels of soil applied pesticides on their fate in the soil, vadose, and groundwater zones.

c. Determine the effect of selected placement of chemicals on their fate in the soil, vadose, and groundwater zones.

d. Improve prediction of the nitrogen budget in the soil.

e. Integrate point and nonpoint source groundwater quality models.

f. Develop simulation models to aid in evaluation of alternate water management and conservation tillage systems for improving groundwater quality.

4. Managers and action agencies need analytical tools (models) to help assess risk and obtain optimal applications of fertilizer and pesticides with minimal groundwater quality effects for given soils, geomorphology, and cultural practices (Priority 9).

Models developed to aid managers will be used to assess the risk of reducing groundwater quality associated with optional agricultural production systems. Models will also be used by action agencies and extension specialists to aid farmers in optional placing and timing of fertilizer and pesticide applications to maximize economic return with minimum adverse effect on groundwater quality. Recommended research approaches are:

a. Develop models to assess the risk of reducing groundwater quality associated with optional water management and agricultural production systems.

b. Develop field office level models for managers, action agencies, and extension specialists to use in aiding producers in optimal placing and timing of fertilizer and pesticide applications and irrigation scheduling that yield maximum economic return and minimum adverse effect on groundwater quality.

5. Data bases and data base management systems are needed to effectively utilize existing and new data for model testing and validation (Priority 12).

The data base needed in research on groundwater quality will be very extensive. Because of the extent of these data and the cost of collection, optimal use of existing or collected data must be ensured, thus requiring the development and use of an efficient data management system. Recommended research approaches are:

a. Assemble existing field and laboratory data into a data base.

b. Develop management systems for data base manipulation.

C. Management and Control

1. The degree to which application technology, irrigation, and changing agricultural production systems affect the chemical and water flux in the soil, vadose, and groundwater zones is not well known (Priority 6).

Even though data are being collected for many water management and tillage systems, little information is available on the effects of these systems on subsurface water and chemical movement. Overall rates of pesticides applied, salts accumulated, or concentrations of nutrients in soils of such systems are not known. These data must be collected and a general assessment made of the impact of such systems on the subsurface chemical environment. Recommended research approaches are:

a. Evaluate the effect of typical errors in application of chemicals used for row-crop production on quality of groundwater.

b. Evaluate the effects of precision chemical application methods on groundwater quality.

c. Evaluate the effects of alternative irrigation systems and schedules and practices on groundwater quality.

d. Evaluate groundwater quality associated with new soil applied chemicals vs. foliar application methods and compare the results with those from conventional uses of chemicals for crop production.

e. Determine if modern chemical waste disposal methods are effective in improving groundwater quality.

f. Evaluate the effectiveness of modern automatic chemical application control systems on groundwater quality.

2. The effectiveness of water management and tillage practices in controlling the movement of water and its soluble biodegradable constituents through an interacting soil medium has not been well established (Priority 7).

   Alternative water management and agricultural production systems may offer the only effective means for improving groundwater quality that has been impacted by salts and agricultural chemicals. Systems must be developed that maintain a satisfactory net economic return to the producer and provide control necessary to ensure good groundwater quality. The effect of such systems on infiltration rates, and fluxes of water and chemicals in the soil and vadose zones must be evaluated. Recommended research approaches are:

   a. Evaluate the use of different agricultural production systems on water and chemical movement into and within the vadose zone.

   b. Determine the effect of tillage and irrigation systems on movement of water and chemicals within the root zone.

   c. Evaluate the impacts of production systems that require less soil applied chemicals for crop production on subsurface movement of chemicals and water.

3. Information on the effects of various water management and agricultural production systems on changes in the soil microbiota which affect the efficacy, persistence and breakdown of agricultural chemicals is inadequate (Priority 10).

   Agricultural production and water management systems impact the dispensation of agricultural chemicals in many ways. Most of them have not been adequately evaluated. Microbial activity in the entire subsurface environment is potentially influenced by changes in organic matter, temperature, oxygen, and moisture levels, all of which respond differently to management systems. Microbial activity plays an important, but not well understood role in the persistence, efficacy and transport of agricultural chemicals. Recommended research approaches are:

   a. Conduct field and laboratory research to determine the effect of cropping systems, irrigation scheduling, chemical structures, formulations, and tillage practices on soil microbiota.

b. Determine the effect of soil microbiota and changing microbial populations on efficacy, persistence, and degradation of chemicals.

c. Determine the long-term effects of pesticides persistence in the soil, vadose, and groundwater zones.

d. Evaluate the effect of new water management and agricultural production systems on soil organic matter content and changes in chemical interactions.

4. New pesticide formulations are needed to improve efficacy, reduce application variability, and minimize the possibility of soil and groundwater contamination (Priority 11).

The introduction of agricultural chemicals into subsurface water can be reduced by several improvements in pesticide formulation and more homogeneous application. New chemical control technology that will lead to development of pesticides with desirable volatility, systemic and controlled release characteristics, and controlled biodegradability could have a beneficial impact on groundwater quality. New strains of bacteria capable of degrading specific pesticides would reduce the chances of groundwater contamination. Recommended research approaches are:

a. Evaluate the use of systemic, foliar applied, and controlled release pesticides under changing water management, tillage, and cropping systems.

b. Determine if the use of controlled release and systemic pesticides decreases the probability of pesticide losses to groundwater.

c. Determine the effect of new high activity pesticides on movement in the vadose zone and the amounts found in groundwater.

d. Discover strains of bacteria that can biodegrade pesticides.

e. Develop biodegradable pesticides.

RECOMMENDED PLAN FOR ALLOCATION OF INCREASED RESOURCES

Resources by Research Priority

Resources needed to initiate the groundwater quality research program described in this report are estimated at $5,000,000 annually, net to the locations. This includes $4,400,000 (22 SY) for expanded intramural research and $600,000 (3 SY) for extramural cooperative research. Because groundwater quality research is very expensive, the recommended level of support is $200,000 per SY.

1. Determine the movement, fate, and patterns of behavior of organic and inorganic substances from application through root, vadose, and groundwater zones.
   Intramural, 4.0 SY's ($800,000).

2. Develop improved physical process models to describe water and chemical movement through soil and vadose zones and aquifers.
   Intramural, 5.0 SY's ($1,000,000).

3. Develop more effective methods of measuring, sampling, and characterizing the spatial and temporal variability, flux rate, and other features of the physical environment in the soil, vadose, and groundwater zones.
   Intramural, 2.0 SY's ($400,000).

4. Define the biological, chemical, and physical factors that govern nutrient transformation and mediate pesticide efficacy, stability, fate, and behavior in root, vadose, and groundwater zones.
   Intramural, 2.0 SY's ($400,000).

5. Determine the source, extent, and occurrence of agricultural chemicals, pesticides, heavy metals, and nutrients in soil, vadose and groundwater zones.
   Intramural, 1.0 SY ($200,000).

6. Characterize the effects of changing application technology, irrigation, and agricultural production systems on chemical and water flux in the soil, vadose, and groundwater zones.
   Intramural, 1.0 SY ($200,000).

7. Evaluate the effectiveness of water management and tillage practices in controlling the movement of water and its soluble biodegradable constituents through an interacting soil medium.
   Intramural, 1.0 SY ($200,000).

8. Develop simulation models for planning and action agencies to predict the impact of alternative agricultural chemical applications, water management, and production systems on groundwater quality.
   Intramural, 1.0 SY ($200,000).

9. Develop management systems models to enable users to obtain optimal application of fertilizer and pesticides with minimal effects on groundwater quality for given soils, geomorphology, and cultural conditions.
   Intramural, 0.0 SY

10. Evaluate the effect of various water management and agricultural production systems on changes in the soil microbiota which affect the efficacy, persistence, and breakdown of agricultural chemicals.
    Intramural, 2.0 SY's ($400,000).

11. Develop new systemic and controlled release pesticides that improve efficacy, reduce application variability, and minimize the possibility of soil and groundwater contamination.
    Intramural, 2.0 SY's ($400,000).

12. Develop data bases and data base management systems for model testing and validation.
    Intramural, 1.0 SY ($200,000).

EXPECTED BENEFITS OF GROUNDWATER QUALITY RESEARCH

A. Background

Today, groundwater problems loom as a major environmental issue for the 80's. Groundwater protection is a very complex and difficult issue with no clear or easy answers. Once contaminated, groundwater may remain so for years, decades, or longer -- essentially reducing or eliminating its resource value for a long period of time. Therefore, knowledge and control of contaminant sources will become even more important than for most other environmental quality problems.

Because subsurface waters originate as surface waters, their chemical compositions reflect their origin as well as the soils and rocks through which they passed. A significant and appropriate role for ARS is an understanding of how agricultural activities and use of agricultural chemicals affect groundwater quality. Cooperation with other Federal and State agencies or institutions may be especially advantageous in evaluating the impacts of agricultural practices on water quality in the root, vadose, and groundwater zones.

Because large quantities of agricultural chemicals are used extensively over much of the United States, agriculture and agricultural production systems are considered potential sources of groundwater contamination. However, timely research on soil and water management systems will provide opportunities for improving groundwater quality.

B. Expected Benefits.

1. The cost of prevention will be far less than the cost of correction. Economically, it is not feasible to decontaminate most groundwater sources that have been contaminated by agricultural chemicals. If the contamination is toxic or otherwise renders the groundwater source useless for its intended purpose, the aquifer must be abandoned. In addition, where re-emerging groundwater is a major part of streamflow, the stream water resource could be adversely affected. If a major supply is rendered useless, the cost of decontamination could be astronomical, far exceeding the cost of prevention. Thus, benefits of the proposed program are expected to be very large.

2. Research on water management, conservation tillage, and other agricultural production systems will provide valuable information on the ecological consequences of such systems. Lack of knowledge exposes agriculture and the general public to risks. Data to be collected will define the impacts and processes whereby persistence, leaching, and residues of pesticides, fertilizers, other agricultural chemicals, and salts will contribute to groundwater quality degradation. Without such data, agriculture may be exposed to unfounded or damaging criticism and possible unnecessary, costly regulation.

3. Improved water management, conservation tillage and, other cropping systems will be developed. Improved cropping practices and management systems will be developed that achieve high yields with minimal hazards to groundwater quality. These improvements will be based upon a better understanding of the processes whereby pesticides, fertilizers, salts, and other agricultural chemicals contribute to groundwater quality degradation. Basic understanding will assure flexibility in providing technology to support changing production systems.

4. Water management practices will be improved. Presently used water management practices can cause salts or chemicals to build up in the soil or groundwater, especially in irrigated regions. Many water management improvements have been made that reduce or control this buildup. Research can provide additional major improvements that will be introduced and accepted by a majority of water users. The greatest impact of improved water management will apply to areas where mixing of good quality groundwater and low quality groundwater can be controlled.

5. New chemical control technologies will be developed. Soil microorganisms and the soil chemistry of agricultural chemicals will be better understood. This new knowledge will lead to a better understanding of the movement and persistence of agricultural chemicals. New controlled-release and controlled-persistence formulations of agricultural chemicals will be developed. The new formulations will biodegrade into products that will not contribute to groundwater quality degradation. New agricultural chemicals will be developed for use at lower application rates. These will be less persistent, less toxic, highly selective, and designed to meet specific needs.

6. New technology, research principles, and models will be applicable to other problems. Discoveries, new technologies, research principles, and models developed as a result of ARS research will be applicable to groundwater quality problems created by toxic waste dumps, lagoons, and other point sources. The research will also improve our understanding of processes that are important in surface water quality, hydrology and transport processes.

7. Fertilizers and pesticides will be applied more efficiently. The possibility of groundwater contamination will be lessened by more efficient formulation, mixing, and application of fertilizers and pesticides. Increased efficiency will reduce wasteful or improper use of products and avoid practices that lead to contamination of groundwater resources. Significant improvements in fertilizer and pesticide use efficiency will reduce the cost of fertilizers, pesticides, and energy use, thus lowering production costs.

POLICY STATEMENT, COOPERATIVE MECHANISMS, AND RECOMMENDATIONS

Implementation and completion of the agriculturally associated groundwater quality research described in the body of this report will require administrative support, cooperation between ARS offices, and cooperation with other agencies. Because of the multidisciplinary nature of the problem, the research will require close coordination between scientists involved in different subproblem areas. The following policy statements, cooperative requirements, and recommendations are intended to develop these parts of the research program.

A. Policy Statement

It is the policy of the Agricultural Research Service, U.S. Department of Agriculture to conduct research and develop technology that will provide groundwater of acceptable quality for irrigation and other agricultural uses, and assure that agricultural impact on groundwater quality is minimal.

B. Cooperative Mechanisms

Maintenance of and active involvement in the following intra- and inter-department efforts will be necessary to develop the research program fully.

1. USDA-USDI Weed Committee Workgroup on Agricultural Chemicals and Water Resources Technology Development and Transfer.
2. USDA-USDI Steering Group on Natural Resources Research.
3. USDA Water Issues Workgroup.
4. USDA Regional Interagency Coordinating Committees.

C. Recommendations

The Work Group recommends that several other committees or workgroups be established to coordinate the proposed groundwater quality research. These consist of:

1. A workgroup between USDA and EPA to coordinate cooperative planning of research on the quality of groundwater impacted by agriculture.

2. A workgroup between ARS and EPA to develop water quality standards for groundwater used for irrigation; i.e., establish acceptable levels of trace organics, pesticides, and salts in irrigation water.

3. A workgroup between ARS and SCS to coordinate ARS response to SCS needs in groundwater quality.

4. A workgroup between ARS and U.S. Geological Survey to coordinate modeling of the vadose and groundwater zones.

5. A workgroup of ARS scientists, from all disciplines involved in groundwater quality research, to coordinate the groundwater quality research program.

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APPENDIX

EXPANDED STATEMENT OF GROUNDWATER QUALITY PROBLEMS BY PROGRAM ORIENTATION

In this section of the report, more specific technical problems are identified for each of the twelve general high priority groundwater problem areas. ARS research locations that can contribute to the high priority problems are identified. This list is not all inclusive; as high priority groundwater problems that are associated with broad physiographic agricultural areas are identified such as the karst areas of the midwest, other ARS locations that are more strategically located may be included. Other ARS locations will contribute in such areas as soil management, fertilizer application and use technology efficiency, and agricultural chemical use efficiency. Locations in parentheses will likely provide extramural support.

A. Chemical and Biological Interactions and Processes

1. The form, fate, and patterns of behavior of organic and inorganic substances as they move through the root, vadose, and groundwater zones are not well enough known to predict their occurence (Priority 1).

   Locations: Beltsville, Riverside, Tifton, Phoenix, University Park, Coshocton, Durant, Baton Rouge.

   Even though there are numerous unsolved problems of water and chemical movement in the root zone, less is known about the vadose and groundwater zones. Very little information is available to characterize the chemical transport, reactions, adsorption and decomposition rates in the vadose and groundwater zones. The degree and type of microbial activity in the subsurface environment is poorly understood and its impact on decomposition of chemicals is not known. Following are specific examples of research problems that need to be considered:

   a. The relation between chemical transport rates, physical properties, state variables and water flux in the vadose zone is not well known or understood.

   b. The in-situ soil and chemical characteristics of the vadose zone have an unknown effect on pesticide adsorption, desorption and degradation.

   c. The reactivity rates of chemicals under conditions that exist in groundwater zones are not fully understood -- are they too fast (or slow) to be of importance?

   d. The effects of pesticide application technique (soil incorporation, surface or foliar applied) on degradation and movement in the vadose zone are not well understood.

   e. Microbial dynamics in the vadose and groundwater zones are unknown.

f. The effect of pesticide formulation on degradation and movement is not well known.

g. The dominant processes controlling salt and chemical concentrations and transport in shallow groundwater and shallow groundwater discharge zones is not adequately known.

2. The biological, chemical, and physical factors that govern nutrient transformation and mediate pesticide efficacy, stability, fate, and behavior in root, vadose and groundwater zones are not known well enough. (Priority 4).

Locations: Beltsville, Riverside, Tifton, Phoenix, (University Park), (Coshocton), Oxford, Stoneville.

This problem requires fundamental research into the dynamics of biological and chemical processes and their interaction with the physical state of the environment in the vadose and groundwater zones. Geochemical processes, pesticide metabolism, microbial activity and other dynamic processes influence the efficacy, stability and fate of pesticides. Solution to these problems will require the close cooperation of engineers and chemists investigating both the state of the subsurface zones and the chemical and biological processes. Following are specific examples of groundwater quality research problems that need to be considered:

a. The effects of enhanced metabolism and edaphic and climatic conditions on pesticide degradation and movement are poorly defined.

b. Basic theory and concepts relating to pesticide persistence, stability and efficacy in different micro-environments is lacking.

c. The effects of naturally occurring geochemical processes on agricultural chemicals are poorly understood.

d. There is little information available on biodegradability (K-factors, half-lives, etc.) of pesticides in deep vadose zones.

e. The retardation coefficient for most pesticides in various soils has not been determined.

f. The exent of chemical removal as a result of denitrification and other chemical processes in the riparian zone along stream systems near groundwater discharge zones is poorly defined.

g. Very little information exists on the effects of additives to soil water systems on biological decomposition of pesticides through co-metabolism or secondary utilization.

   h. Adequate knowledge of the extent and degree of microbial activity in the vadose zone and its impact on the transport of nutrients and pesticides is lacking.

   i. The micro-biological factors that control pesticide efficacy are poorly understood.

   j. The effects of crop residues on pesticide efficacy, stability and fate need to be better developed.

   k. The effects of salts on microbial activity and pesticide degradation processes in the vadose zone is not known.

3. The source, extent, and occurrence of agricultural chemicals (pesticides, heavy metals, salts, and nutrients) is not known well enough to predict their concentration and impact (Priority 5).

   Locations: Beltsville, Tifton, Phoenix, University Park, Durant, Columbia.

   Most fundamental research will require an assessment of the nature and concentration of agricultural chemicals in the vadose and groundwater zones. In some cases, this could involve extensive groundwater investigations; for example, the identification of plumes associated with point sources of contamination or the characterization of spatial and temporal variability of chemical concentration. Following are specific examples of groundwater quality research problems that need to be considered:

   a. The spatial variability of salt and chemical concentration in the vadose and groundwater zones is poorly defined.

   b. The seasonal variability of salt and chemical concentration in the vadose and groundwater zones is not adequately described.

B. Model Development and Testing

1. Analytical descriptions (models of the physical processes governing the movement of water and chemicals through soil, vadose, and groundwater zones) are not complete enough to characterize water quality features (Priority 2).

   Locations: Beltsville, Riverside, Tifton, Phoenix, University Park, Coshocton, Durant, Fort Collins.

   Accurate models of all the physical processes governing chemical dynamics and the fluxes of water and chemicals through the subsurface zones are needed as an aid in groundwater quality research. Modeling activity and fundamental research on the physical processes must proceed together to obtain synergistic benefits. Physical process models are also needed before good predictive and management models can be developed. The process models developed must include chemical and physical processes, and the dynamics of microbial activity and the integration of these processes with each other. Following are specific examples of groundwater quality research problems that need to be considered:

a. The accuracy, precision, and ability to deal with heterogenous systems are not satisfactory.

b. Variables such as temperature, pH, and concentration gradients are driving forces that have not been adequately considered in existing groundwater quality models.

c. Descriptions of chemical subsystems and cycles, water fluxes, sorption and desorption kinetics, redox, and affected microbial population dynamics in the vadose zone are incomplete.

d. Physical and biological processes are not well integrated.

e. Pest dynamics and thresholds are important factors not well described or considered in existing groundwater quality models.

2. Existing technologies do not provide adequate methods of sampling, measuring, and characterizing the spatial and temporal variability, flux rates, and other features of the physical environment in the soil, vadose, and groundwater zones (Priority 3).

Locations: Beltsville, Tifton, Phoenix, Durant, University Park.

Improvement in understanding and the ability to characterize groundwater quality depends upon fundamental research and development of physical process models. Both of these in turn are dependent upon a much better characterization of the subsurface than we now have; i.e. spatial and temporal variability of conductivity, cracked formations, preferencial flow paths, etc. New instruments and more efficient methods of mapping mapping subsurface features are needed. Following are specific examples of groundwater quality research problems that need to be considered:

a. Our ability to incorporate the effect of heterogeneity on conductivity is poor.

b. Existing methods of characterizing, measuring, and monitoring different layers in of groundwater zones need improvement.

c. Existing methods of sampling and characterizing cracked formations and similar features are inadequate.

   d. Tools or information bases, available to the user, to enable him to effectively utilize existing models at an economically feasible level are inadequate.

   e. Representative regional geological patterns that can improve a users' ability to describe or efficiently represent an area have not been developed. They may offer help in use of existing groundwater models.

   f. Tracers hold the potential to help characterize the subsurface configuration - the size of an area that can be characterized this way is not known.

3. Planners and action agencies need analytical tools (models) to predict the impact of alternative agricultural chemical applications, water management, and and production systems on groundwater quality (Priority 8).

   Locations: Riverside, Tifton, University Park, Coshocton, Boise, Fort Collins.

   The development of predictive models to evaluate the impact of alternative water management and production systems on groundwater quality will evolve from basic process models and fundamental research. Such models will be needed to predict the nitrogen budget of soils under different management systems and to assess rural groundwater quality subject to both point and nonpoint sources of contamination. Scientists will use such models in a simulation mode to help them develop management system models for action agency use. Following are specific examples of groundwater quality research problems that need to be considered:

   a. The N budget in soils and its contribution to the groundwater needs to be better understood.

   b. Better methods of predicting percolate moving in the vadose zone are needed.

   c. Planners need models that integrate both point and nonpoint sources of chemical input, to assess rural groundwater quality. The point sources could be any of a variety of waste disposal or other loadings.

   d. Planners need simulation models that describe alternative agricultural production systems and their impact on water quality in the vadose and groundwater zones. These are needed to compare alternatives and develop economically feasible production systems that ensure good groundwater quality.

   e. Researchers need simulation models that can be used to study such issues as the scale factor: how to tie results from small to large scale, i.e., subsurface water quality assessment from the field to the watershed.

4. Managers and action agencies need analytical tools (models) to help assess risk and obtain optimal applications of fertilizer and pesticides with minimal groundwater quality effects for given soils, geomorphology and cultural practices (Priority 9).

   Locations: Riverside, Tifton, University Park, Coshocton, Boise,
   Fort Collins.

   Models developed to aid managers will be used to assess the risk of reducing groundwater quality associated with optional agricultural production systems. Models will also be used by action agencies and extension specialists to aid farmers in optional placing and timing of fertilizer and pesticide applications to maximize economic return with minimum adverse effect on groundwater quality. Following are specific examples of groundwater quality research problems that need to be considered:

   a. Managers need models to assess the risk of reducing groundwater quality associated with optimal water management and agricultural production systems.

   b. Managers, action agencies, and extension specialists need field-office level models to aid producers in optimal placing and timing of fertilizer and pesticide applications and irrigation scheduling that yield maximum economic return and minimum adverse effect on groundwater quality.

5. Data bases and data base management systems are needed to effectively utilize existing and new data for model testing and validation (Priority 12).

   Locations: Beltsville, Riverside, Tifton, University Park, Coshocton,
   Fort Collins.

   The data bases needed in research on groundwater quality will be very extensive. Because of the extent of these data and the cost of collection, optimal use of existing or collected data must be ensured, thus requiring the development and use of an efficient data management system.

C. Management and Control

1. The degree to which application technology, irrigation, and changing agricultural production systems affect the chemical and water flux in the soil, vadose, and groundwater zones is not well known (Priority 6).

Locations: Beltsville, (Tifton), Phoenix, Coshocton, Columbia, Ames.

Even though data are being collected for many water management and tillage systems, little information is available on the effects of these systems on subsurface water and chemical movement. Overall rates of pesticide applied, salts accumulated, or the concentrations of nutrients in soils of such systems are not known. These data must be collected and a general assessment made of the impact of such systems on the subsurface chemical environment.

2. The effectiveness of water management and tillage practices in controlling the movement of water and its soluble biodegradable constituents through an interacting soil medium has not been well established (Priority 7).

   Locations: Beltsville, Coshocton.

   Alternative water management and agricultural production systems may offer the only effective means for improving groundwater quality that has been impacted by salts and agricultural chemicals. Systems must be developed that maintain a satisfactory net economic return to the producers and provide the control necessary to ensure good groundwater quality. The effect of such systems on infiltration rates, and fluxes of water and chemicals in the soil and vadose zones must be evaluated. Following are specific examples of groundwater quality research problems that need to be considered:

   a. Infiltration rates on soils with different water management and conservation tillage systems are sometimes increased and at other times decreased. The reasons for this are not readily understood.

   b. The impact of different water management agricultural production systems on water and chemical fluxes in the vadose zone is poorly understood.

3. Information on the effects of various water management and agricultural production systems on changes in the microbiota which affect the efficacy, persistence and breakdown of agricultural chemicals is inadequate (Priority 10).

   Locations: Beltsville, Tifton, Stoneville.

   Agricultural production and water management systems impact the dispensation of agricultural chemicals in many ways. Most of them have not been adquately evaluated. Microbial activity in the entire subsurface environment is potentially influenced by changes in organic matter, temperature, oxygen, and moisture levels all of which respond differently to management systems. Microbial activity plays an important, but not well understood, role in persistence, efficacy, and transport of agricultural chemicals. Following are specific examples of groundwater quality research problems that need to be considered:

a. The long-term effects of pest control chemicals on persistence is not fully understood.

b. Little is known of the effect of conversion to no-till on soil organic matter content and changes in chemical interactions.

c. Changing chemical structures and formulations, impact soil microbiota in unknown ways.

d. Cropping systems, rotations, double cropping, and alternative water management systems impact the dynamics of microbial populations in unknown ways.

e. The effect of changing microbial populations on the efficacy, persistence and breakdown of pesticides is mostly unknown.

. New pesticide formulations are needed to improve efficacy, reduce application variability, and minimize the possibility of soil contamination (Priority 11).

Locations: (Beltsville, (Tifton), Stoneville, New Orleans.

The introduction of agricultural chemicals into subsurface water can be reduced by several improvements in pesticide formulation and more homogeneous application. New chemical control technology that will lead to development of pesticides with desirable volatility, systemic and controlled release characteristics, and controlled biodegradability could have a beneficial impact on groundwater quality. New strains of bacteria capable of degrading specific pesticides would reduce the chances of groundwater contamination. Following are specific examples of groundwater quality research problems that need to be considered:

a. Specific formulations are needed to effect desired volatility characteristics.

b. Systemic and controlled release pesticides are needed to respond to changing tillage and other cropping systems.

c. Information on the effect of controlled release and systemic pesticides on groundwater quality is practically non-existent.

d. Flux rates of new high activity pesticides (sulformyl urea) in the vadose and groundwater zones are not known.

e. Strains of bacteria are needed that can degrade specific pesticides.

f. Biodegradable strains of pesticides are needed.

TESTIMONY BEFORE U.S. SENATE ENVIRONMENTAL AND PUBLIC WORKS COMMITTEE

December 12, 1985

W.E. LARSON

My name is William E. Larson, Professor and Head of the Soil Science Department at the University of Minnesota. I am Past President of the American Society of Agronomy.

I am pleased to appear before the U.S. Senate Environmental and Public Works Committee and discuss fertilizer impacts on groundwater quality. Certainly, efficient fertilizer use is desirable in agriculture and groundwater quality is of national concern. The linkages between the two needs discussion and analysis.

Efficient fertilizer management requires a careful balance between inputs (sources of nutrients) and outputs (biomass production).

Inadequate Wells and Sinkholes

Nitrate occurence in rural groundwaters may arise from farmyard wastes filtering down through broken well casings or inadequately protected wells. In areas where shallow soils occur over fissured geologic materials such as limestone, sinkholes may develop and funnel surface waters directly into aquifers. Such an area occurs in Major Land Resource Area 105 in Minnesota, Iowa, Wisconsin, and Illinois. In the past, the sinkholes were sometimes used as dumps for farm and other organic wastes. As the organic wastes decomposed, they rapidly provided undesirable water contaminants.

Nitrogen Inputs.

Nitrogen is required by all living matter. It is abundant in nature - in plants, soils, and air. There are many sources of nitrogen in the soil, including native soil nitrogen, inputs from fertilizers, manures, legumes, atmospheric deposition, and free fixing organisms. The average virgin Cornbelt soil contained about 9000 to 18000 pounds of nitrogen per acre. About one-third (3000 to 6000 pounds per acre) of this has been removed from the soil since cultivation began 150 to 200 years ago (about 25 pounds per year). Even before cultivation began, nitrate from soil organic matter leached through the soil and small amounts reached groundwater. Olson and Hergert found some nitrate under native sandhill ranges in Nebraska that had never been fertilized. Fixed nitrogen in rainfall contributes about 5 to 15 pounds per acre per year, depending upon closeness to industrial sources and weather conditions. Free-fixing microorganisms in the soil contribute nitrogen, as do symbiotic organisms associated with legumes, e.g., soybeans, alfalfa, clovers, and native legumes. A recent study at the University of Minnesota indicated that symbiotic organisms in association with an average crop of soybeans may fix 70 pounds per acre per year. Likewise, a crop of alfalfa may fix 100 pounds per acre. This nitrogen will be converted to water soluble nitrate and become available to subsequent crops, or leached in percolating waters. Nitrogen as fertilizer is applied regularly to non-leguminous crops such as corn and small grains. The average nitrogen applied to corn in Minnesota, Iowa, and Illinois in 1984 was 110, 139, and 147 pounds per acre, respectively. The average nitrogen applied to wheat in Minnesota and Illinois was 57 and 66 pounds per acre, respectively.

My point in citing these sources and amounts of nitrogen is to make clear that there are abundant sources of nitrogen, in addition to fertilizer, in the soil, and if nitrified, could be leached into groundwaters.

Nitrogen Outputs.

Nitrogen when applied to the soils may be sorbed by the plant, incorporated into soil organic matter, remain as mineral nitrogen in the soil, converted to gaseous atmospheric nitrogen (denitrification), or leached to groundwaters.

Denitrification losses are not specifically known, nor is the amount of nitrate N reaching the groundwater, but tile line losses plus the residual quantities in the soil indicate that minimal nitrates reach the groundwater when excessive rates of fertilizer N are avoided.

Non-leguminous crops require large amounts of nitrogen to produce economical yields. For example, a 150 bushel per acre crop of corn will sorb about 200 pounds of nitrogen per acre in its above ground parts (grain and stover); a 100 bushel per acre wheat crop about 150 pounds per acre; a native grass stand yielding 3 tons of forage about 60 pounds per acre.

Dr. C.J. Overdahl of our department recently summarized 25 research reports on nitrogen management from Minnesota. A few examples of the research follow.

Through use of isotopic nitrogen in fertilizer, Castro accounted for 96 percent of applied nitrogen on a Doland silt loam at Morris, Minnesota. He found 69 percent in roots and above ground portions of corn and the rest in the soil to only a 3-foot depth.

Gerwing observed that high nitrogen rates on an irrigated sandy loam soil resulted in nitrate movement to the shallow aquifer. With proper timing and rates of N application, however, the crop utilized most of the nitrogen applied. Applications of 160 pounds per acre of nitrogen, split four times, resulted in little if any nitrate movement to the shallow aquifer; while 70 percent from a one-time application moved below the corn root zone, some reaching the aquifer.

Walters studied the fate of fertilizer nitrogen on an Estherville sandy loam over three seasons, using large steel tanks buried in the soil and 15N labeled urea. About 17 percent (14 pounds per acre) of added nitrogen occurred in the leachate from 80 pounds per acre of nitrogen; with 160 pounds 30 percent loss was found (48 pounds).

Randall (1975 through 1984) showed that nitrate concentrations some years are greater than 10 ppm in tile water, even where no nitrogen fertilizer was added to the soil. In two consecutive dry years, crop yields were low and no tile flow and no nitrate loss occurred. This resulted in a buildup of nitrates in the upper 4 feet which is susceptible to loss in years of normal rainfall. Nitrates in tile water ranged from 31 pounds of nitrate per acre for the 60 pounds per acre nitrogen application, to 202 pounds of nitrate per acre with the 240 pounds per acre rate. Considerably more N was lost through the tile lines with fall nitrogen applications than with spring treatments. Corn yields were optimal at 180 pounds of N per acre, excess being more vulnerable to loss. At this same station at another site, 10-year average yields for continuous corn, or corn in a corn-soybeans rotation, optimum yields required slightly over 160 pounds of nitrogen per acre per year.

At Lamberton, a slightly lower rainfall area in Southwest Minnesota, results after 12 years of N treatments show that N lost in the tile discharge accounted for 23 percent of the N applied at the near optimum rate of 100 pounds per acre for corn. Where 400 pounds per acre annually was applied, losses in tile lines were as high as 41 percent. The nitrogen was applied in single spring applications.

Nitrogen Management

There are many sources of nitrogen in the soil (inputs) and sources of removal (outputs). Our studies indicate we can manage nitrogen inputs from fertilizers, manure, and leguminous plants. We have little control over the amount mineralized from the soil, or from atmospheric precipitation. The amount mineralized from the soil is determined by soil and weather characteristics. Atmospheric deposition is determined by industrial inputs and weather. Desirable output in the form of crop removal can be managed.

Our studies at the University of Minnesota indicate that nitrogen fertilizers can be managed on different soil types to avoid contamination of groundwater. To do so, we recommend the following:

- apply nitrogen close to the time the crop needs it.
- use nitrogen fertilizer in economical amounts, but avoid excess nitrogen additions.
- use proper soil nitrate testing, where appropriate, to establish a quantitative measure of residual nitrates in the profile. Accurate nitrogen can then be based on a realistic crop yield goal and a measure of residual nitrate amounts in the soil. Cropping history is helpful in the absence of the test.
- on course (sandy) textured soils and soils shallow to groundwater aquifers, use timeing and split application methods for nitrogen additions.
- use nitrification inhibitors to reduce rate of conversion from ammonium to nitrate in high or moderate loss areas to increase nitrogen use by the crop.
- reduce soil movement to surface waters by soil conservation practices.

- give proper credit to manure applications, N supplied by legumes and the previous crop when deciding on amounts of nitrogen use.

Fragile Soils

On very coarse-textured (sandy to gravelly) and shallow soils it is difficult to provide sufficient fertilizer nitrogen for an economically produced corn or cereal crop without considerable nitrogen leakage to groundwaters. Unless managed carefully, it may be best to take some of these fragile soils out of cultivation and convert them to less intensive use in a conservation reserve. Other effective uses include grass, forestry, or recreation. While I do not know how much fragile land is now in cultivation, it may be as high as 20 to 40 million acres, nationally.

Other Fertilizers

Sulfate-sulphur will move downward through sandy soils. However, sulfur is used in small amounts, and there are no known health hazards from sulfur in groundwater.

Other forms of fertilizer elements are readily sorbed by the soil and do not move with leaching waters in any significant amounts. Phosphorus is sorbed tightly by the soil and, except in extremely coarse- textured (sandy to gravelly) soils, moves little in the soil by percolating waters. Likewise, potassium and micro elements are readily retained near the point of application in the soil except in very coarse-textured soils.

Discussion

Fertilizer usage is essential to cost-efficient American agriculture. Today's farmer gets more return from the efficient use of nitrogen than from most other production inputs. Fertilizer elements need to be used in balanced amounts. Fertilizer can be used responsibly with little danger of groundwaters contamination, or they can be used irresponsibly with some dangers occurring.

The interactions among fertilizers, soils, crops, and weather are almost infinite. To understand and predict these interactions, and thus predict the most cost and environmental effective management strategies will require considerable research and educational efforts. This will require a coordinated effort by University, government, and industry personnel. We endorse the Groundwater Quality and Management Research and Extension Plan outlined by the Experiment Station Committee on Organization and Policy. The research and educational efforts are essential to a healthy America. Healthy in terms of low cost food production and a healthy environment.

Summary

Of the fertilizer nutrients, only nitrogen in the form of nitrate is readily leached into groundwaters and may be of concern. In addition to nitrogen fertilizer, there are many sources of nitrogen in the soil. Likewise, nitrogen may be removed from the soil by crop uptake, denitrification, or by leaching. Careful management of nitrogen (balanced with other fertilizer nutrients) inputs and crop uptake can minimize dangers from nitrogen leaching into groundwaters. The interactions among fertilizer, soils, crops, and weather are complex. Expanded research and education programs are desirable to insure and maintain a healthy agriculture and environment.

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